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OVERSEAS INFORMATION SERVICES

THE question whether the overseas services of the British Broadcasting Corporation should continue to be grouped with broadcasting in the United Kingdom, and with television, as the monopoly of a single corporation, was placed by the Beveridge Committee as the second of the fundamental issues it was asked to resolve. Nevertheless, overseas broadcasting was manifestly regarded as a secondary issue by the Committee, and its comments have received little attention. Mr. John Coatman has argued cogently for placing the overseas services under organizations in appropriate relation with the British Broadcasting Corporation, and for restoring the Corporation to its old position as the broadcasting authority for the people of the United Kingdom alone. Since overseas broadcasting was intended to be a projection, not of the government of the day in Britain, but of Britain and of the nature of the British way of life and liberty, the Beveridge Committee admitted that overseas broadcasting should be a function of some body independent of the Government, but was not prepared to recommend division or devolution. It recommended instead continuance of the existing arrangements for division of responsibility for overseas broadcasting between the government and the British Broadcasting Corporation, and this recommendation was accepted by the Government in a White Paper issued last May.

The cost of the overseas services of the B.B.C. will thus continue to be borne by a grant-in-aid from the Exchequer, and the cost will be calculated as the definable additional expenditure incurred on account of the overseas services. This arrangement does not, however, meet one important criticism made by the Beveridge Committee, the report of which directed attention to the different line taken by the Government in fixing the deduction to be made by the Post Office from gross licence revenue to cover the costs of collecting the fees and of the interference service. The Post Office includes in those costs a share of the total overheads of the Post Office, a practice for which there is every justification in view of the liability of the discharge of the proper and normal functions of the Post Office to be obstructed by the multifarious duties it undertakes for other Departments of State. The Beveridge Committee was unanimous that the charge made by the Corporation to the Government for overseas services should in future be calculated on the same principles and include overheads.

The silence of the White Paper on this point, coupled with the dubious honesty, to say the least, of the fifteen per cent deduction from the net licence revenue, gives point to the Beveridge Committee's remark that in the financial arrangements for overseas broadcasting the Government has been attempting to obtain benefits without paying for them. On this parsimony and its consequences the Ninth Report from the Select Committee on Estimates* turns a

* Ninth Report of the Select Committee on Estimates. Session 1951–52. Overseas Broadcasting. Pp. xxvii+146. (London: H.M.S.O., 1952.) 6s. 6d. net.

searching light, and the Government emerges from this scrutiny with little credit. The Estimates Committee has grave doubts whether the present procedure is any longer an appropriate method of ensuring, on one hand, that the Corporation has the necessary freedom to carry out its task, and on the other that Parliament has the requisite control over the directions in which public money is spent.

When the B.B.C. was designated as the chosen instrument for broadcasting overseas, the government was anxious that the freedom of the Corporation should be curtailed as little as possible. This was fully appreciated by the Beveridge Committee, and was one reason for its recommending the continuance of the existing arrangement. The Estimates Committee, however, is now convinced that the real control exercised by Departments of State, especially the Foreign Office, the Service Departments and the Colonial Office, has considerably increased. With such increased departmental influence, closer Parliamentary control must obviously be exercised.

It must be borne in mind in considering this report from the Estimates Committee that its functions are limited to the examination of the estimates, and to reporting on the form in which they should be presented or on possible economies. Nevertheless, the Select Committee has taken a wide view of its responsibilities, and its outspoken comments may do something to stimulate action to remedy the damage already caused by short-sighted parsimony.

Virtually the sole income of the British Broadcasting Corporation for its overseas services is the grant-in-aid, amounting to £4,750,000. The overseas programmes of the Corporation are sent to countries and in languages prescribed by government departments through the Postmaster-General. They include the General Overseas Service broadcast entirely in English and designed primarily for British communities abroad, including troops stationed overseas, and for the Commonwealth and Empire, and two main groups: the European Services and the Overseas Services, the latter comprising the North and Latin American, Eastern, Far Eastern, Pacific and South African and Colonial Services. The transcription studios in London provide a universal service of transcriptions in English running to six hundred programmes a year. The value of this service lies in the furtherance of the purpose of 'projecting Britain'. But to obtain the full value of the service the Corporation believes a local representative is needed; withdrawal of the Corporation's officers from South America is expected to result in a considerable curtailment of the use of B.B.C. recordings there.

Besides this, the 'external' services of the B.B.C. include the 'monitoring' service, developed in wartime, of listening to and reporting on the broadcasting services of other countries. Although carefully co-ordinated with the Americans, this monitoring service, to which the powers of prescription have been extended by the new licence, has a staff of 572, out of the 3,307 employed by the external services, and is estimated to cost £454,000; nor does there appear to be any prospect of reduction here.

The parsimony of the Government outlook, however, is shown by the unrealistic hope of the Treasury, in spite of the evidence of this report, that economies in overheads will avoid the need for a supplementary estimate. To this attitude the Estimates Committee in its examination of the purpose of external broadcasting supplies a wholesome and much needed corrective. It notes, naturally, the general lowering of morale resulting from successive cuts in the grant and consequent reduction in staff, as well as the resignations of foreign staff and increasing difficulty in recruiting suitable staff from abroad. It emphasizes the long-term character of broadcasting to other countries. A reputation for objectivity is only built up over a period of years, and once a service is abandoned it is difficult to restore. Wave-lengths unused, even for part of a day, are quickly snapped up by other broadcasters. Thus the Committee cites the abandonment of the Latin American services over the past two years.

In this connexion the Estimates Committee expresses surprise that the Board of Trade is not a prescribing department. Manifestly, British overseas trade must play a major part in providing the resources necessary to win the 'cold war', and this depends largely upon prestige. Broadcasting is directed to peoples, not to governments, and in the free world it is the peoples far more than governments that buy. It is thus not enough for the Board of Trade to be represented in regard to overseas broadcasting by the Foreign Office; and one of the Estimates Committee's most important recommendations is that the Board of Trade should be more closely associated with the external services and should be designated as one of the prescribing departments.

The Estimates Committee rightly observes that the influence of broadcasting on backward peoples is potentially great, and that the Colonies are likely to continue to rely to a large extent upon the services offered by the Corporation. "In fact," it is remarked, "broadcasting has become one of the main links of the Commonwealth." But it is not the only link, and the expenditure on broadcasting for such purposes needs to be reviewed in the light of other expenditure directed towards the same end, whether in the field of education or in other ways.

What is obviously required is a wider outlook than has characterized either the present Government or its predecessor. There must clearly be, as the Select Committee rightly indicates, a continuing watch over all such external services, to ensure that no service once instituted is allowed to run on after its marginal usefulness in the national interest has passed; but such a scrutiny must be informed by clear conceptions of what overseas broadcasting can contribute to the maintenance of British needs and interests, and by accurate knowledge of what is being done by other agencies in influencing the minds of peoples. It has, in fact, to take account of what is being done not merely by the British Council and the Colonial Office in the field of overseas education, but also of the work of bodies such as the United Nations Educational, Scientific and Cultural Organization.

In all this, science is only one facet, but an important one; and scientific men should consider how closely they are affected, and in what ways they could assist the more efficient and effective projection of the mind of Britain and of her achievements in science, no less than in other matters of the mind, so as to promote international understanding and provide a firmer basis for world peace. The greater freedom of scientific intercourse, whether it be by the exchange of publications, or the interchange of visits between individuals or institutional staff, depends in part on such mutual understanding as overseas broadcasting is designed to encourage. Even in the free world, much remains to be done in the way of the removal of restrictions before travel between one country and another is as free as is desirable for the advance of science itself; and such barriers are unlikely to be removed purely by unilateral action.

The Estimates Committee's report also makes it manifest how closely this question bears on that of technical assistance to the under-developed areas. That point is argued more closely in an article, "Science and Foreign Policy", by E. M. Friedwald, in a recent issue of *Impact of Science on Society* (Paris: Unesco). Mr. Friedwald urges that scientific and technical assistance is likely to become a major element in international relations and a powerful instrument for promoting goodwill between nations. It can only be fully effective, however, when political obstacles have been removed by the appropriate means; in this work overseas broadcasting and agencies such as the British Council count for much.

What seems to follow, therefore, from this inquiry of the Select Committee on Estimates into overseas broadcasting is that some further measures, which it was not within the scope of that Committee to suggest, are required. It recommends a system of quinquennial grants for the overseas services of the B.B.C., in order to enable the Corporation to plan ahead for reasonable periods in providing what is essentially a long-term project. The administration of such a grant and the continuing scrutiny of the appropriateness of particular services to changing conditions may well call for the establishment of an independent body with a wide purview and responsibility, possibly analogous to the University Grants Committee, and competent to survey not merely the external services of the British Broadcasting Corporation but also other activities by which British ideals and institutions are made known to the world and British prestige is maintained. Such a body might, for example, not merely eliminate any overlap existing between the work of the British Council, the external services of the British Broadcasting Corporation and the work of the Central Office of Information; it might equally eliminate much of the ill-informed and sometimes carping criticism to which all these activities are frequently subject. It could help to bring to the work of the British Council a stability which that body no less than overseas broadcasting needs if its work is to be planned and co-ordinated reasonably.

The first step in that direction, however, would seem to be the institution of an investigation, as was suggested by Mr. John Coatman some eighteen months ago. Besides inquiring into the opportunities for achieving greater economy and efficiency in this field, on which it is estimated some £11,000,000 is at present expended annually, by co-ordinating the work of the B.B.C., the British Council and the Central Office of Information, Mr. Coatman suggested that such a committee should inquire into the desirability of relieving the B.B.C. of all responsibilities in connexion with the political warfare type of broadcasting by transferring it to an appropriate government department or agency. The safeguard to objective overseas broadcasting which such transfer would give is obvious, and Mr. Coatman argued the point more fully in a subsequent article in *Public Administration* (29, 160; 1951), in which he also developed further reasons for a third suggestion which he would have the proposed committee consider, namely, replacement of direct transmissions of certain overseas services by a transcription service of British Home Service programmes.

Under the federal system which Mr. Coatman proposes he believes that such transcriptions would truly represent the life and culture of the whole nation. Moreover, by broadcasting on the national services, better reception conditions would be secured as well as much larger audiences than are at present reached, while two more medium wave-lengths would be made available for home broadcasting. The small committee envisaged by Mr. Coatman as competent to examine and report on these questions should be competent to examine the wider issues, and conduct the continuing surveillance suggested above if it is eventually constituted a permanent body with appropriate powers. The Estimates Committee's report strongly supports the arguments already advanced by Mr. Coatman, and the inquiry suggested appears to be the first step necessary to ensure both economy and effectiveness in interpreting the mind of Britain to the world, with all the possibilities that such activities hold for the advance of science itself and for enabling science to make its full contribution to the growth of international understanding.

HEAVY WATER

Physical Properties and Analysis of Heavy Water

By Isidor Kirshenbaum. Edited by Harold C. Urey and George M. Murphy. (National Nuclear Energy Series, Manhattan Project Technical Section, Division 3, Vol. 4A.) Pp. xv+438. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 45*s*.

THIS new volume of the National Nuclear Energy Series is devoted to a topic which is of importance to a growing number of research workers who are using non-radioactive isotopes in tracer investigations. Much has already been published on the physical properties and analysis of heavy water; but in earlier publications there is a measure of disagreement. The subject was studied in great detail during the Second World War, particularly by a team working at Columbia University, and it is

this new material which constitutes the main part of the present volume. The author and editors have, however, avoided the disjointed effect which was apparent in some earlier volumes of the series. The subject has been treated as a whole, and a coherent review is given both of the work done during the War and of other work published in the open literature.

The first chapter, on the physical properties of heavy water, deals with determinations of such properties as specific gravity, the melting and boiling points, vapour pressure, viscosity and refractive index, and with thermodynamic data. All the more important precise determinations appearing in the literature are reviewed, and full experimental details of new work are given. The author then proceeds to a discussion of exchange reactions involving heavy water, commencing with the calculation of the equilibrium constant for the reaction $H_2O + HD = HDO + H_2$ and its experimental investigation. A similar treatment of exchange reactions involving ammonia and carbon dioxide follows.

The large section of the book on mass-spectrographic analysis falls into two parts, the first devoted mainly to instruments and general techniques of measurement, and the second to problems connected with the isotopic analysis of heavy water by the mass spectrograph. In both parts there is much that is new, and many techniques are described in great detail. These include both methods for decomposing water to obtain hydrogen for analysis, and also methods for equilibrating water samples with hydrogen or deuterium gas in the presence of a catalyst. The ways of analysing water for the oxygen isotope content are also described.

Various other methods have been applied from time to time in analysing heavy water for its deuterium content. Of these the author has chosen those involving density determinations by means of a float or a falling drop, and the refractometric method, for detailed discussion. The existing literature is reviewed, and a good deal of very precise work done during the War is described. These methods are particularly useful for detecting small variations in the abundance of hydrogen and oxygen isotopes in natural waters. Results in this field, which are described in the last chapter, may be of great value to any future hypothesis concerning variations in the isotopic ratio of terrestrial materials.

The great value of this book lies in its critical approach. The author and editors have themselves been closely concerned with much of the outstandingly fine experimental work described. Their many refinements of technique, and the careful assessment of the results of their experiments and those of others, constitute a major contribution to the subject.

H. J. Emeléus

A PHYSICIST LOOKS FORWARD

The Next Million Years

By Sir Charles Galton Darwin. Pp. 210. (London: Rupert Hart-Davis, Ltd., 1952.) 15*s*. net.

WHENEVER Sir Charles Darwin sets out to write, we know he will produce something both unusual and interesting, and in this book he has not disappointed us. He is looking forward. But unlike most of his predecessors in this kind of writing, he is not limiting himself to a period of a century or two when people very much like ourselves will be carrying on developments with which we are familiar or even have started: instead he is trying to foresee the long-range "average history" of the world.

Instead of the classical cause-and-effect method, Sir Charles adopts the statistical method based on the laws of probability. He points out that the actions of an individual human being are as unpredictable as the movements of an individual molecule of a gas in a containing vessel; but the average effects produced by an enormous number of molecules can be predicted with great accuracy because, as the number of chances becomes larger and larger, the effects of any single event become less and less important and they tend to cancel out. In statistical dynamics, he says, an enormous superstructure can be built with confidence out of a foundation that might appear to be very narrow. Pursuing the analogy further: we may, he thinks, reasonably hope to find the Boyle's law controlling those unpredictable molecules, human beings, if we can find internal conditions analogous to the condition of being a conservative dynamical system, and external conditions analogous to the containing vessel.

The latter presents the lesser difficulty: the containing vessel is the earth, about which we already know a great deal—probably enough for general forecasts. The internal conditions analogous to those of conservative dynamical systems are the properties and characteristics of human nature, and here some generalities seem to emerge which hold for the mass however widely individuals may deviate. These properties and characteristics change, but over sufficiently large numbers of events only very slowly, and on analogy with the past, Sir Charles assumes that it will take about a million years before they have gone far enough to make man so different from what he is now that he will become a new species. He does not think that these changes could be expedited by some dictator or ruling caste using hormones or eugenic methods such as have so speedily produced changes in domesticated animals: such differentiation into specified types is rendered improbable by the fact that man is "wild" rather than "domesticated". The necessary ruling caste, he thinks, could never emerge. Man as a wild animal will always multiply up to the limit set by the available food supplies, and in consequence, however greatly these may be increased, there will always persist a large starving marginal population. With increasing scientific control natural selection will lose some significance as a factor in determining the chances of living, and some physical deterioration may well follow its elimination.

Our present political systems are likely to be modified. Democracy lacks survival value. The state of parasitism on the community engendered by modern social conditions is impermanent because in the end the parasite destroys its host and then itself perishes: the process is likely to be hastened by the concomitant reduction of the more intelligent, these being now driven to have few or no children. It will be the non-parasitic communities that will survive, and those that multiply most will dominate the earth by sheer numbers. For this reason the author thinks that world agreement to control population could never be attained: an aggressor nation or *bloc* would never permit their people to restrict their numbers, and other nations that wished to survive would have to follow suit. Government would possibly be by

some "hero" who has sufficient sense to adapt himself to a society of dense population. Here intellect will count, but morality may not, since "in a highly competitive world, the sinner has many advantages over the saint". Desire for children there must be, however, or the increased population could not eventuate, and *Homo sapiens* may well change into *Homo pædiphilus*. Man, however, is a thinking being, and the author discusses the potent effect of creeds on his life and action—using the word "creed" to denote the whole body of tenets derived from teachers, the surrounding society and direct personal experience. He instances China, where the belief in ancestor worship imposes on each man the duty of leaving descendants to continue the practice. As the children of abler people are more likely to survive in a population where many are on the verge of starvation, the creed has a strongly eugenic effect. Rome, with a different creed, collapsed under the attacks of the barbarians, while China, equally attacked, after two generations has absorbed and assimilated its Mongol conquerors and continued its course unperturbed: its people now form one-fifth of the human race. But in the long run and over great periods of time, Sir Charles is sceptical about the permanent effects of creeds.

Space does not permit an adequate summary of the author's forecasts: his final picture is, as he admits, rather gloomy. He foresees a densely crowded world with a permanent starving margin, where the people, looking back regretfully on the prodigious stores of energy and other natural resources that we have so lavishly wasted, are compelled to a harder existence than ours and set a lower value on human life. Conditions of work will become more severe for the less efficient, and the only mitigation will be for the more intelligent. There will be more discontent, and no notable addition to the sum of human happiness. Periodically there will come better times, "Golden Ages"—probably the greatest of these will have been the nineteenth century. Civilization is unlikely to be ended by war; but there is the chance that some irresponsible individual might blow up the whole planet with a sufficiently large hydrogen bomb when the secret of making such potent instruments is discovered.

Given the premises, the conclusions follow logically. The premises assume a universe where events fall out as in statistical dynamics, without intervention by a Deity as postulated by the Christian religion: a universe without a plan.

It would be interesting to compare this forecast with some of its predecessors. H. G. Wells used the cause-and-effect method, and with his marvellous gift of extrapolation was able to predict changes which, apparently fantastic at the time, nevertheless came about later. His picture, too, like that of Sir Charles, is depressing. Both forecasts are immeasurably remote from the radiantly optimistic visions of the nineteenth-century writers such as Edward Bellamy, whose "Looking Backwards", with its blissfully happy people progressing onwards and upwards for ever, was accepted by even so realistic a Victorian as Sydney Webb—who once told me more than sixty years ago that that was what the world would be like when we got Socialism.

The book is extremely interesting, and it will serve a useful purpose if it leads politicians to look forward more than the usual five years, and to try thinking out the long-term result of their policies.

E. John Russell

ORGANIC CHEMISTRY OF PHOSPHORUS

Organophosphorus Compounds

By Prof. Gennady M. Kosolapoff. Pp. vii+376. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 60*s*. net.

FROM the early days of systematic organic chemistry, organic compounds of phosphorus have been the subject of considerable investigation. Beginning in the late 1860's, the eminent German chemist Michaelis devoted a long and illustrious lifetime to their study, and he and his school were responsible for laying the foundations of the chemistry of phosphorus compounds. There followed the classical researches of Arbuzov in Russia, and more recently British chemists have made outstanding contributions. The names of F. G. Mann and W. C. Davies are associated with valuable studies in the phosphine field, and to A. R. Todd we owe the development of several new methods of phosphorylation, elegant syntheses of substances related to nucleic acids, and notably the first authentic preparation of adenosine triphosphate.

Several organophosphorus compounds have to-day acquired industrial status for diverse applications as solvents, plasticizers, insecticides, surface-active agents, flame-proofing compositions, lubricating-oil additives and warfare agents. Schrader pioneered the use of phosphorus compounds as insecticides, and the discovery of systemic activity in certain derivatives has led to important developments. But undoubtedly the main interest in organophosphorus compounds derives from their biological significance. One need only mention the nucleic acids, phospholipids, phosphoproteins and amino-acids, various coenzymes, nucleotides, phosphorylated derivatives of sugars and the fact that two of the more recently discovered vitamins—vitamin B_{12} and pantothenic acid—seem to function biologically as phosphate derivatives, to realize the importance of phosphorus compounds in the manifestations of life phenomena. Yet it is not unusual to find but scant reference to the organic chemistry of phosphorus in standard text-books even to-day. The appearance of this first treatise on the subject in English is therefore particularly welcome.

The author, Prof. G. M. Kosolapoff, who is of Russian extraction, has been able to draw on the fund of valuable information available in the scientific literature of that country. For more than a decade he has himself carried out researches in this field, originating and improving syntheses of organophosphorus compounds. Written from the point of view of an organic chemist, the book is intended primarily for organic chemists. Its scope is strictly limited to a review of preparative methods for various types of phosphorus compounds with discussion of their general characteristics. The interesting subject of the naturally occurring phospholipids, for example, is considered outside the scope of the volume, and biochemists will regret that no attempt has been made to treat biochemical aspects. Even so, Prof. Kosolapoff has rendered a signal service to the chemical community by filling a significant gap in the literature.

A serious difficulty in compiling this book was the confusion arising from lack of a universally adopted system of nomenclature for phosphorus derivatives. In his classification of compounds into types the

author has departed from current practice in some respects, and he has eliminated as far as possible specific names which have been needlessly perpetuated. The term 'phosphinic' acids ($R_2P(O)OH$) has been abandoned, the acids being regarded as derived from phosphoric and phosphorous acids by replacement of hydroxyl groups by the radicals. The use of 'chloro-phosphonate' has also been rejected in favour of chlorophosphate.

Each chapter follows a general pattern: a brief introductory statement about the class of compounds dealt with, followed by detailed consideration of preparative methods applicable to compounds of that type, discussion of their general characteristics, a compilation (up to January 1950) of known authentic compounds with their physical constants and mode of synthesis and, finally, all pertinent references. Individual compounds with properties not typical of the group are noted. To avoid ambiguity owing to the several systems of nomenclature now in common usage, the tabulations of known compounds are based on structural formulæ in progressive order of complexity. These take the place of a comprehensive index of names at the end of the book. While this feature has the merit of permanency, it makes it a little more difficult for the non-specialist to trace any specific compound.

Laboratory workers in this branch of chemistry will value this book not only as a source of information on synthetic methods but also as a complete dictionary of organophosphorus compounds. J. Idris Jones

ANTHROPOLOGICAL STUDIES OF ARAB LIFE

Birth and Childhood among the Arabs

Studies in a Muhammadan Village in Palestine. By Dr. Hilma Granqvist. Pp. 289. 1947. 25 Danish kr.

Child Problems among the Arabs

Studies in a Muhammadan Village in Palestine. By Dr. Hilma Granqvist. Pp. 336. 1950. 30 Danish kr. (Helsingfors: Söderström and Co.; Copenhagen: Einar Munksgaard.)

DR. HILMA GRANQVIST'S earlier two-volume work in English, "Marriage Conditions in a Palestinian Village" (Helsingfors: Academic Bookstore, 1931–35), aroused, and merited, quite unstinted praise. Its excellence from a methodological point of view, its manner of presentation and its penetrating thoroughness are repeated in the two books now under review. During 1925–31 she spent three years in Palestine for the purpose of attaining "an objective knowledge of the Arab people in order to help us to understand the culture of Bible times, and therewith the sources of Christianity". To achieve such an aim, she wisely decided to concentrate on a detailed study of a small community, that of the village of Artas, bordering the desert south of Bethlehem, in preference to a large-scale but less intensive survey of Muhammadan Arabs as a whole. She has succeeded in a brilliant fashion and has permanently enriched anthropological and sociological literature by revealing a microcosm of Arab—one might fairly say Semitic—values and sentiments that have persisted since the days of the Prophets and still endure. Specialists in other fields have suggested 'Eber or Heber as the eponym of both 'Hebrew' and 'Arab', and here is a mass of evidence for the supremacy of custom in the very area from which the two ancient peoples (now, alas, so deeply at odds with each other) have made their most profound impress on Western civilization. The emphasis that recent students have laid on institutional factors in the determination of culture seems nugatory when compared with this predominance of custom, and, to judge from the quality of Dr. Granqvist's field-work, her sympathetic insight into Arab life and ambitions has shown that she combines to an extraordinary degree the dual role of anthropologist and philanthropist.

"Birth and Childhood among the Arabs" does not follow the tenets of one contemporary psychological school in stressing early toilet habits as decisive in the formation of a child's personality. Dr. Granqvist's net is far more widely cast, but the draught of ethnographical fishes brought up by it is in no sense less miraculous. The main topics comprise pre-natal and post-natal observances, the paraphernalia of pregnancy and birth—how little significance, incidentally, does the caul seem to possess in Palestinian folk-belief—as well as nursing, children's games and work, education and the development of character and, finally, circumcision. It may be thought that Dr. Granqvist was particularly fortunate in choosing as her principal informant the blind widow Alya, and in securing the good offices of the daughter of the Alsatian missionary family of Baldensperger, resident in Artas since 1840, in whose house she lodged; but this would do scant justice to the erudition she herself brings to the treatment of her subject and the wealth of comparative material she cites from Biblical and other sources in support of her own findings. These confirm her contention that the possible influence exercised by the child on the religion and language of the Bible has been underestimated, and they put theologians and anthropologists alike in her debt.

The second volume, "Child Problems among the Arabs", moves from the sphere of custom and the artless to that of the largely, if not wholly, more sober one of genealogical data and statistics. Here, too, Dr. Granqvist displays an impressive grasp of method which will be the envy of those concerned with population studies, and it is difficult to evaluate the careful inferences she draws from her observations in other than superlative terms. The first chapter is devoted to an analysis of names. Teknonymy, a word introduced by Tylor to denote the calling of parents after their children, is restricted to the eldest son in the Near East, where the practice is known as *kunya*. Once more the whole subject is illuminated by abundant documentation from literary sources. The scope of the remaining parts of the book includes sex-ratio, fecundity and fertility, child mortality and the *dits* relating to it, the treatment of ailing children by therapeutic and supernatural means, the position of children in a patriarchal society, child–parent relationships, and the importance of the social and familial environment to a child's upbringing. An extensive bibliography, a list of Biblical parallels and a detailed index to both volumes complete the contents.

It may be remarked without exaggeration that Dr. Granqvist's researches establish a new standard in ethnographical technique. Seldom does one come across investigators so completely at ease with the minutiæ of their inquiry, and in the present instance the author has evidently profited from the previous studies she made of purely religious problems, which, together with her work on family life among the

Arabs ("Arabiskt Familjeliv" (Stockholm: Åhlen and Söners förlag, 1939)), were written in Swedish. In common with other Scandinavian scholars, the Finns have developed the recording of their indigenous folk-culture to an extent that, in its literary aspect, is unmatched elsewhere, except perhaps in Ireland. (On the situation in Great Britain it is better to maintain an embarrassed silence.) Dr. Granqvist has equalled her fellow-countrymen's achievement in the superb contribution she has made to the study of a culture alien to her own. J. C. TREVOR

FOUNDATION OF GOOD ROADS AND RUNWAYS

Soil Mechanics for Road Engineers

(Department of Scientific and Industrial Research: Road Research Laboratory.) Pp. xxiv+541+90 plates. (London: H.M. Stationery Office, 1952.) 30*s*. net.

THE work of the Soil Mechanics Section of the Road Research Laboratory can be followed by interested persons in the many excellent publications issued, for example, in its 'technical papers' on compaction, soil survey procedure and pavement design, or in its 'road notes' on frost and drought damage, to quote only a few. In the volume under notice, these appear to have been collected together and carefully edited to form the most authoritative book on soil mechanics for road engineers at present available.

The book gives a complete picture of the soil mechanics knowledge that might be of use to a road engineer, from soil identification and classification, mechanical and chemical testing, soil stabilization and compaction, on to the ultimate goal of pavement design, each chapter being supplied with adequate references for further information. There are particularly interesting chapters on the movement of soil moisture and the investigation of foundation failures.

Each paragraph of the book is numbered, and this would lead one to suppose a good deal of cross-referencing. In fact, virtually none exists, except in broadest terms, and this is one of the weaknesses of the book. Each chapter can almost stand on its own, and this has led to a certain amount of repetition. For example, in one of the final chapters on bearing capacity, shearing resistance, Coulomb's equation and Mohr circles are referred to as if they had not been previously mentioned, whereas, in fact, there is a very full chapter devoted to shear strength, after which it is gratuitous to be told that "granular soils are more capable of carrying load if they are confined than if they are not".

The chapter on consolidation more logically comes before that on shear strength: then the $\varphi = 0$ result for undrained shear tests becomes more understandable. Similarly, it would be more logical to treat bearing capacity before pavement design. These criticisms could be met easily by efficient cross-references.

It would have been helpful if, in the section on the determination of specific gravity, typical values for soils had been given. Later on, an implicit value of 2·65 is used indiscriminately for clays and sands alike.

The effect of pore water pressures on shear strength, although initially correctly stated, does not appear to have been fully understood. For example, in saying that "the greater the drainage attained during a test, the greater will be the shearing resistance", the effect of the decrease in pore water pressure which takes place during an undrained test on a dilating soil has been overlooked.

Each chapter has its introduction, telling what is going to be said in it, and a summary telling what has been said. This is convenient for a technical journal where a number of different topics are treated; but here it would appear unnecessary. Again, the nine pages at the front devoted to figure titles seem unnecessary.

The diagrams and photographs are of a high quality, and the book is well produced apart from numerous printing errors which ought to be corrected before the next edition appears. K. L. NASH

BIRDS OF GREENLAND

Grønlands Fugle (The Birds of Greenland)

Text by Finn Salomonsen; Plates by Gitz-Johansen. Part 3. Pp. 349–608+plates 37–52. (København: Ejnar Munksgaard, 1951.) 3 vols., 42 dollars; £14 15*s*. 0*d*. Map of Greenland, prepared for The Birds of Greenland by Geodetic Institute and Finn Salomonsen. 40 cm. × 60 cm., 10 Danish kr.

THIS is the final part of an interesting work (for Vols. 1 and 2 see *Nature*, **167**, 744 (1951) and **169**, 48 (1952), respectively) and deals with the auks, birds of prey, owls and passeres. There is some evidence that the great auk bred in south-east Greenland in the sixteenth century. According to Greenland chronicles of Bjørn Jonssøn, Lutra Clemens, an Icelander, on a voyage to Greenland between 1580 and 1596, landed at Gummborjarn's Skerries, north-east of Angmagssalik, and loaded his boat with great auks. At a much later period, during 1768–74, this bird was a regular visitor in small numbers to west Greenland, and Fabricius tells us that they were killed for food by the Greenlanders, and the Danish inhabitants made blankets out of the skins. The last bird to visit Greenland was killed at Disko Island in 1821. The little auk, in contradistinction to its large namesake, is reputed to be the most numerous bird in the world, and Dr. Finn Salomonsen quotes one authority who estimates that in the Scoresby Sound district alone there are five million pairs. All the large breeding colonies are in the north, and those in the south are much smaller, sometimes only a few pairs. When the auk comes ashore to breed, they are preyed on by foxes, glaucous gulls and gyr-falcons, to say nothing of the numbers netted by Greenlanders for winter food. When at sea they run the gauntlet of seals, fish, and even whales, according to Salomonsen. Nevertheless, in spite of all this, there does not appear to be any signs of the birds becoming reduced in numbers.

Of the three birds of prey breeding in Greenland, the most interesting is the gyr-falcon, a circumpolar species. In the heyday of falconry the white form of this bird was in great demand and was usually only in the possession of kings, or very important people. Actually, in the pursuit of game it had not the dash of the peregrine, and Dr. Salomonsen's notes on the food and manner of hunting of these two birds is of great interest. He remarks also that the gyr-falcon is easily driven away by a pair of long-tailed skuas, or a pair of ravens, which would not be the case with the peregrine. The classification of the gyr-falcon

has always been a matter of dispute owing to the differences in colour, which fall into three phases—white, grey and dark. The author follows Schiøler and other Danish ornithologists, and divides the forms in Greenland into two races, *Falco r. candicans*, the white bird breeding in the north, and *F. r. obsoletus*, breeding in the sub-Arctic and low Arctic zones, and which may be either grey or dark in colour with many intermediate coloured birds.

Among the passeres, the field-fare calls for attention, since it first began to nest in Greenland in 1943 and is now a regular breeder; this is an interesting case of colonization. From the systematic list at the end of this part we learn that 224 species and subspecies have been recorded from Greenland, and, out of these, 64 breed regularly, 58 have only occurred once and most of the remainder are casual visitors.

There are a very good bibliography and map. It is to be hoped that Dr. Salomonsen will see his way to bring out in the near future a cheaper and smaller edition, without plates, of this important fauna.

N. B. Kinnear

LIFE OF THE WESTERN ATLANTIC COAST

The Living Tide

By N. J. Berrill. Pp. xi+256+16 plates. (London: Victor Gollancz, Ltd., 1951.) 16*s.* 6*d.* net.

Prof. N. J. Berrill's excellent contribution to the ever-growing number of popular books about life in the sea is concerned mainly with the inshore life of the east coast of the United States. There are occasional excursions elsewhere, particularly to Salcombe and the coasts of Cornwall—scenes of the author's youth—but for the most part the theme is distinctly North American, though quite a number of the species described are common to both sides of the Atlantic. From Loggerhead Key in the Dry Tortugas northwards to Maine a number of outstanding examples of the marine flora and fauna are described with a bare minimum of technical words. The writing, never dull, presents a depth of sound biological knowledge in a light and entertaining manner that is wholly delightful. Especially noteworthy are the accounts of the breeding of the turtle, of the upside-down jellyfish *Cassiopeia* in the moat of Fort Jefferson, of *Limulus*, and of the skull and breeding of the crucifix fish (a species of cat-fish). There are first-rate chapters devoted to the lobsters, squids and seals of Maine.

It is a pity that Prof. Berrill, in his endeavour to eliminate all technicalities, leaves the biologist on the eastern side of the Atlantic to puzzle out the identity of some of the animals he mentions. There is need for an appendix giving the scientific equivalents of such popular appellations as the sea potato, the grey snapper, the blue crab, the quahog and the soft-shelled clam. The last-named, we are assured, is "sand-gaper" in an English fish-market. There are occasional lapses of style, as in the sentence about the fanning feet of the barnacle pulling in a handful of water and food; and there are occasional errors of fact, as in the statement that *Zostera* is a terrestrial grass which has invaded the sea. But to dwell on these rare slips would be to give a false impression of a most readable and accurately written book.

Compared with the text, the photographic illustrations are disappointing. Two of the pictures are from habitat groups in the New York Natural History Museum; but the fanciful captions may lead the unwary to assume that they are photographs from life (unless, indeed, the wires suspending the trigger-fish happen to be noticed). The remaining photographs are from life and are of very mixed quality. The best, a good one, is of living squids; a few photographs are not in proper focus and should not have been included.

D. P. Wilson

THE SUGARCANE

Botany of Sugarcane

By Dr. C. van Dillewijn. Pp. xxiii+371. (Waltham, Mass.: Chronica Botanica Co., 1952.) n.p.

The author has produced this considerable volume for the best of reasons, namely, that he wanted to do so and because he felt that such a volume, which relates to a major tropical crop, if not overdue, would certainly be timely. In contrast to other works on the sugarcane, which have been mainly practical, technological, historical or economic in their conception and outlook, this book is what its title declares it to be: essentially a work of botany. In it, on the basis of a bibliography of some 617 titles, the author has produced an account of the sugarcane plant in all its phases of germination, growth, development and reproduction. As perhaps might be expected, the data available to the author are somewhat uneven: some aspects have been the subject of intensive research, while others have remained comparatively neglected, those aspects which stand in a close relation to agricultural or technological aspects being most amply documented. Thus photosynthesis occupies thirty-two pages, respiration less than four.

The first section is devoted to a detailed illustrated account of the morphology and anatomy of the stem, buds, leaves, inflorescence and roots, and the second to physiological aspects, including germination, tillering, growth, chemical composition, nutrition, water relations, photosynthesis and respiration. In a contemporary work it is perhaps surprising that the genetical and cytological aspects are not included, though a chapter is devoted to the evaluation of vegetative characters in the classification of varieties, while the part played by the introduction of new varieties in safeguarding the industry is fully recognized.

The author rightly considers that cane-growing should be treated as a science, and with due emphasis he directs attention to the fact that there is a great gap between the relatively low efficiency in the field and the high efficiency in the factory. This he attributes to lack of knowledge, to failure to make use of knowledge that is available, and to dependence on tradition, local opinion and empiricism rather than on knowledge of the botany of the sugarcane and the related principles of its cultivation. In the present volume an attempt is made to remedy these defects and to make available to workers in all countries a comprehensive work of reference. The author and his publishers are to be congratulated on their achievement, and the hope may perhaps be expressed that the Chronica Botanica Company will regard this present volume as but one of a series of monographs on the botany of important crop plants.

C. W. Wardlaw

Advanced Five-Figure Mathematical Tables

By C. Attwood. Pp. v+69. (London: Macmillan and Co., Ltd., 1951.) 4*s*. 6*d*. net.

THIS book is intended as a continuation of the same author's "Practical Five-Figure Mathematical Tables", published in 1948. The collection of tables provided, however, is complete in itself, but the material might well seem strange to anyone unacquainted with the more elementary volume.

The trigonometrical tables are expressed in decimals of a degree, rather than in the usual intervals of six minutes, and an alternative set is also available with arguments in radians. As before, with emphasis on interpolation, small-interval tables have been supplied for the critical ranges, where the method of mean proportional parts is no longer adequate.

The tables of hyperbolic functions, which follow, include the hyperbolic tangent, not normally featured in books of this kind. Very detailed exponential tables for both positive and negative arguments between 0 and ± 7·5 (which incidentally render the presence of logarithm tables unnecessary) are followed by tables of the factorial function for intervals of 0·001 in the range from 0 to 1. In these, the author uses the symbol $x!$, instead of the more classical $\Gamma(x+1)$, for $\int_0^\infty e^{-t}t^x dt$, with consequent minor modifications in the recurrence formula.

The final tables should prove most useful, containing as they do complete elliptic integrals of both kinds (with k^2 as argument) and ordinates and areas of the normal probability curve. In conclusion, a very comprehensive set of explanatory notes and formulæ, together with several numerical examples illustrating the correct use of the tables, serve to complete a book which is well produced and clearly printed.

J. H. PEARCE

Selective Toxicity with Special Reference to Chemotherapy

By Prof. Adrien Albert. (Methuen's Monographs on Biochemical Subjects.) Pp. xii+228+5 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1951.) 7*s*. 6*d*. net.

MESSRS. METHUEN'S "Monographs on Physical Subjects" have long provided the student of moderate means with authoritative and modestly priced treatments of subjects not generally well covered by the orthodox text-books, and it is gratifying to know that similar provision is now being made in biochemistry. It is significant of the progress made by biochemistry in recent years that what might have been the first in the new series, namely, the late Dr. N. U. Meldrum's "Cellular Physiology", actually appeared in a series of monographs on biological subjects, and the publication of a series of monographs on biochemical subjects is a fitting tribute to the mature status to which biochemistry has now attained.

In this volume, based on a series of lectures delivered at University College, London, in 1949, students of biology and chemistry, coming fresh from their respective trainings in fundamental science to the hybrid subject of selective toxicity, will find much food for thought. While the choice of material in places emphasizes Prof. Adrien Albert's personal research interests and points of view, illustrations are drawn from a wide range of fields as far removed from each other as selective herbicides and local anæsthetics. After defining selective toxicity and describing applications, Prof. Albert discusses physicochemical aspects with reference to drug-receptor interactions, the role of ionization in the acridine antiseptics, chelation and trace metals. Chemotherapy is then reviewed, and various pharmacological themes are adumbrated in the closing chapter.

Chemical Indicators

By Prof. O. Tomíček. Translated by A. R. Weir. Pp. x+258. (London: Butterworths Scientific Publications, Ltd., 1951.) 21*s*.

THE subject of chemical indicators is of interest to many workers in the fields of pure and applied chemistry and biology, and, since advances are steadily reported in all its branches, a modern treatment is always welcome. The present volume, by an authority in the field, should be valuable to many kinds of workers.

The treatment is modern, the general theory of acids and bases being used throughout, and the fundamental equations are clearly deduced and their use explained in such a way that they should be easily understood by non-specialists. This is an important feature, since a proper use of indicators depends on a knowledge of recent advances in the theory of electrolyte equilibria which are not easy to follow unless simply presented. The equations are illustrated by numerical examples, which aid in elucidating their meaning.

The book includes a full account of apparatus and experimental methods, is provided with useful tables, and is very complete, since it deals not only with acid-base indicators but also with oxidation-reduction indicators, adsorption indicators, and fluorescent indicators. Full references to the literature are given. In every way this is a most useful and attractive book, which may be warmly recommended.

Theoretical Aerodynamics

By Prof. L. M. Milne-Thomson. Second edition. Pp. xx+414. (London: Macmillan and Co., Ltd., 1952.) 40*s*. net.

A REVIEW of the first edition of this treatise appeared in *Nature* of May 8, 1948. The fact that a second edition has been called for so soon is evidence of public appreciation of the book and of the vitality of aeronautical science.

The second edition is substantially identical with the first, except for the very notable addition of a chapter, running to 51 pages, devoted to supersonic 'conical flows'. By a conical flow is meant one in which the velocity vector, pressure and temperature are all constant on each straight line through a fixed origin. Such flows lend themselves to theoretical treatment of a relatively simple nature and there are many useful applications, for example, to wings of 'delta' plan form which are now being used on some high-speed aircraft. The new chapter is a valuable and welcome addition to the book. Some eccentricities of nomenclature have been amended in this edition; but the treatment of the mechanics of flight and of stability remains as before and is too short to be adequate.

In spite of the substantial increase in the size of the book and of the notorious increase in costs in recent years, the price of the book has not been raised. The author and publisher are to be congratulated on producing a book which, from all points of view, is good value for money.

W. J. DUNCAN

BEHAVIOUR OF SOCIAL INSECTS

THE social insects have for a long time attracted the attention of biologists, and, undoubtedly, the epoch-making discoveries of Prof. K. von Frisch and his colleagues have led to a great revival of interest in these groups, more especially perhaps in the bees and ants. At the recent meeting of the British Association in Belfast a part of Section D (Zoology) devoted a day to papers and discussions on the behaviour of ants, bees and termites; it was unfortunate that wasps could not be included.

During the morning session, under the chairmanship of the president of the Section, Prof. A. D. Peacock, members considered certain aspects of the behaviour of ants and termites. The behaviour of honeybees was the subject of the afternoon session, when Prof. C. C. Varley took the chair.

Ants and Termites

In his paper, Dr. J. H. Sudd (University College, Dundee) described a number of experiments on the possibility of forming colonies of Pharaoh's ant (*Monomorium pharaonis*) with various numbers and proportions of queens, workers and pre-adults, and discussed the significance of these results in the spread of natural infestations of this ant, which has established itself in such places as kitchens and bakeries. High humidity and temperature, and darkness in the nest cell, are necessary for successful culture of colonies of this ant in the laboratory.

Wheeler thought that, in general, ants could found colonies in one of two ways. Most commonly a sexual couple or a fertilized queen left the parent colony and raised brood, thus forming the nucleus of a new colony. In other cases some kind of swarming took place in which a sexual couple together with a number of workers left the parent colony and founded a daughter colony. Wheeler considered that swarming was uncommon in temperate species. In *M. pharaonis*, which is probably a tropical species, there is no sign of swarming. Mating takes place in the nest; but experimental attempts to found new colonies with sexual forms alone have always failed. This is not, however, because queens will not feed themselves, nor because isolated queens refuse to lay eggs.

What is even more remarkable is that attempts to found colonies with a population of one or more queens and a number of workers have also failed, although eggs were laid and in some cases larvæ were produced. In order to found colonies in the laboratory both workers and young stages are necessary; but a queen is unnecessary and may even be harmful, since she appears to compete with the larvæ for the attention of the workers and tends to be 'ritually' fed at the expense of the larvæ. After a few hours, however, the queen is deserted and the larvæ receive more attention. Such feeding of the queen by workers appears to be a truly instinctive act, with a releasing mechanism, and to have a variable threshold. The lowest ratio of workers to pre-adults with which a colony has been founded successfully was forty workers to fifty-three pre-adults, of which twenty-one were pre-pupæ.

Trapping has indicated the probability that established colonies of this ant have a habit of wandering as a whole, or of dividing and then rejoining, and perhaps it is not legitimate to think of the population of an infested building as consisting of a number of discrete colonies.

It seems clear that the spread of infestation of *M. pharaonis* is not a simple matter. For example, although it is no doubt possible for this species to be disseminated in a cake, it would be necessary for quite a large number of worker ants and pre-adult stages to be present if the establishment of a colony in a new situation is to result.

Dr. D. M. Vowles (University of Oxford) considered the social structure of the ant colony in terms of the behaviour patterns of the individual ant. He described how workers of *Lasius niger* will carry their brood from a light into a dark area and said that, if one ant is made to retrieve too many larvæ, this activity ceases, although other activities do not. This can therefore be interpreted as exhaustion of the drive for brood retrieving. The method of handling the brood when retrieving it varies in different species—the inherited innate component differs. Furthermore, the method of handling individual larvæ and pupæ depends upon their size, shape and similar characteristics, the taxis component of instinctive behaviour allowing adequate adjustment. The releasing stimulus seems to depend on a combination of size, odour, solidity and the hunched shape of the anterior end of the larva.

In *Myrmica ruginodis* the foraging activity, both of the individual and of her colony, can be intensified by increasing the proportion of larvæ to workers in the colony. Increasing the number of pupæ does not result in any increase of foraging activity. There are two types of foraging activity, one for sugar, which takes place continuously and represents the individual ant's feeding activity, and the other for protein, which is stimulated by the presence of larvæ, but not pupæ, and is parental activity.

Food exchange between workers is an important factor in the integration of the colony. The results of Dr. Vowles's work with *Camponotus pennsylvanicus* suggest that, when adult ants appear to be begging for food, they are really seeking it anywhere that they can find it and will take it from the first available source. They have learned early in life that they can obtain it from other workers, and he said that, as a rule, food exchange is a question of a would-be donor finding a willing acceptor. The signal for regurgitation appears to be a touch on the mouth-parts, and the antennæ of both donor and acceptor appear to be used during food exchange for finding and orientating the other ant's head. It is the donating, rather than the receiving, behavioural mechanism which has evolved in ants.

Dr. Vowles concluded by suggesting that ant behaviour is essentially parental and that nearly all the duties performed by workers could readily have been carried out by their solitary ancestors. During the evolution of social life, worker ants have had to lose certain behaviour patterns, such as those involved with courtship, mating and egg laying, which if present would tend to disrupt the social life of the colony. One must distinguish between sexual and parental behaviour; only the former has become suppressed in worker ants.

Mr. S. J. Holt (Nature Conservancy, Edinburgh) gave some details of his work in a Scottish forest on the quantitative assessment of the foraging activities

of colonies of the wood ant, *Formica rufa*. From a nest a number of well-defined, branching tracks radiate, each of which terminates in a large pine tree up which the foragers climb in search of honeydew. Each individual ant usually, but not invariably, uses one particular track on her way to and from the nest, and the speed at which she walks and, therefore, the rate of foraging and the rate of flow of foragers from the nest vary with the temperature. If one sets up check points along a track, one finds that the number of foragers passing along the track decreases the farther one gets from the nest, and, although most of the ants (about 80 per cent) keep to the track, a certain number leave it at intervals and spread out to hunt in the areas between the radiating tracks.

By marking individual ants belonging to a particular isolated colony, Mr. Holt has been able to study the economy of their colony. Each forager carried at one time about 0·0019 gm. of honeydew or, if she was collecting insect food, a load weighing on an average 0·008 gm. Each forager on a good day brought home food equivalent to about half her own body-weight. *Formica rufa* is very fond of midges, and on those days when midges settle in numbers on the rowan trees, the foragers tend to desert the pines and go to the rowans instead.

Prof. J. E. Webb (University College, Ibadan) considered the swarming behaviour of termites as an adaptation to the particular type of social life adopted by this order of insects in comparison with that found in the higher social Hymenoptera. He pointed out that the termites differ from most social insects in that each colony has both a king and a queen. The 'swarming' in termites of winged males and females is a prelude to colony formation, during which the male requires not only to contact the female but also to remain in association with her throughout the hazardous period before the first chamber of the new nest is formed. The chances of survival of the termite pair are much less than those, for example, of single fertilized queen ants, and the fact that they survive at all would appear to be due largely to the complex pattern of behaviour that winged termites exhibit during the process of 'swarming'.

The male and female termites emerge from the nests in which they have been born in large and approximately equal numbers around dusk on the day following the first rains; thus there is a reasonable chance of mating occurring between individuals from different colonies, and, further, at this time the soil will be soft, thus permitting easy excavation, and will remain so long enough for the colony to become sufficiently large to regulate its own humidity conditions.

On first emerging, the male and female termites are positively phototactic and are attracted by, and fly towards, the brightest light. The females settle on the ground some distance from their parent nests and shed their wings. The males search for females, making short flights interspersed with periods of running in all directions on the ground, and do not generally shed their wings until they have found females. When a male finds a female, he caresses the hind part of her abdomen with his mouthparts and antennæ, and this stimulates her to run forward with the male following 'in tandem'. As soon as such contact has been established, the female becomes negatively phototactic and runs away from the light in search of a suitable site, where both she and her mate begin to excavate the first chamber of the new nest. Should the pair become separated, the female promptly stands still with her abdomen raised and flattened while the male runs in circles seeking her. When contact is re-established the male resumes his caresses, which once more stimulate the female to run forward.

Prof. Webb pointed out that with respect to their swarming behaviour the termites appear to be unique among social insects. He said that the behaviour pattern he had described for *Macrotermes nigeriensis* is essentially similar, except for minor details, to that of all other termites, and suggests that this behaviour during swarming is one of the basic characteristics of the Isoptera and may well be one of the important factors which has initiated development of the social habit within the group.

During the short discussion which followed these four papers, Dr. S. H. Skaife (South Africa) suggested that it would be more correct to speak of the 'mating flight' of termites rather than 'swarming', as this phenomenon is in no way comparable with the 'swarming' behaviour of honeybees. Prof. Webb replied that, while agreeing that these two phenomena are not comparable, he thought that the term 'swarming' is well understood when used for describing the mating behaviour of termites and ants.

Dr. Sudd asked whether antennal stimulation by one ant is important in inducing another ant to give food to it. Dr. Vowles replied that he is convinced that it is not and, on the contrary, that it rather appears that an ant which wishes to give up food stimulates another ant to receive this food by offering it to her. Dr. C. G. Butler remarked that this also appears to be true in the case of worker honeybees. Most of the rest of the discussion, in which various members took part, was concerned with an attempt to find an all-embracing definition of social life, but no definition that was acceptable to all was suggested.

Prof. Peacock closed the discussion with a few remarks, in the course of which he said that he was very interested to find that there is so much in common in the behaviour shown by the different species of social insects that had been discussed.

Honeybees

The opening paper in the afternoon session was given by Mr. C. R. Ribbands (Rothamsted Experimental Station) on new evidence concerning the language of honeybees, in which he discussed some of the recent work which he and his collaborators, Dr. H. Kalmus and Mr. H. L. Nixon, have completed. Since this work has been recently discussed in *Nature* (September 13, p. 438), it is not reported in detail in this article. Suffice it to say that their experiments have demonstrated that food transmission among the honeybees of each colony is the foundation of the division of labour, and also, since they have shown this to be the basis of individual colony odour, enables the bees of a colony to distinguish their comrades from strangers and thus to protect their hive.

Dr. C. G. Butler (Rothamsted) briefly described some of the observations of Mr. J. B. Free and himself on the guarding of their hives by worker honeybees. He said that honeybees do not guard the entrances of their hives unless their colonies have been disturbed in some way, such as by the presence of numbers of strange bees, and that they are much more inclined to become and remain alert at those times when little or no fresh food is being brought into their hives and, similarly, to give up guard duties on the advent of a

honey-flow. Almost any bee will assume guard duties when necessary, and, should numbers of strange bees attempt to enter the hive of a really alert colony, mass fighting sometimes takes place and many bees are killed. In such cases both the owners of the hive and the intruders apparently regard the hive as their own and attempt to defend it. However, such mass fighting between guard bees seldom occurs unless beekeepers are careless, and the fate of bees which attempt to enter hives which they have mistaken for their own is largely dependent on their own behaviour.

Guard bees recognize members of their own colony, as well as intruders from other colonies, by the scent of their bodies; but there is evidence that robber bees are recognized as such by their characteristic hesitant flight in front of the hive entrance before the guards can approach them closely enough to identify them by their scent. Guards always attempt to kill robber bees, but seldom attempt to kill bees which have strayed to the guard bees' hive by mistake.

A paper on chemo-reception in the honeybee was then read by Mr. G. D. Glynne Jones (Seale-Hayne Agricultural College). He pointed out that laboratory experiments with honeybees are often valueless since the bees do not behave normally; on the other hand, it is impossible to control all the variables in the field. He therefore carried out his experiments in a glass-house where many of these disadvantages could be eliminated. While attempting to measure the effectiveness of certain substances such as phenol, acetic acid and dimethylphthalate as bee repellents, he obtained results which showed that the bees' response follows definite patterns, some of which appear to be of interest in throwing light on the mechanism of chemo-reception in the honeybee. The responses of honeybees to sucrose solutions containing concentrations of phenol ranging from 0·1 to 0·000001 per cent were measured using different techniques. In one series of experiments the bees were offered an alternative to the test solution in space; in another series an alternative was offered in time rather than space. When the alternative was offered in time, a distinct sigmoid response curve was obtained involving a very narrow range of concentrations, a solution of 0·01 per cent being completely acceptable whereas a 0·05 per cent solution was completely unacceptable. But, when the alternative was offered in space, a double response curve was obtained, the concentrations involved ranging from 0·05 to 0·000001 per cent.

Mr. Glynne Jones said that, when the alternative of unadulterated sugar syrup is offered in space, it may be assumed that concentrations of phenol above 0·000001 per cent are detected by the olfactory sense organs of at least some of the bees, and a proportion chooses the pure sugar syrup. As the concentration of repellent is increased above this level, the proportion of bees choosing pure sugar syrup also increases until a maximum is reached, after which further progressive increases in concentration result in reduction in the repellent effect. This reduction may be due to the fact that the olfactory sense organs become very quickly fatigued when exposed to these concentrations of phenol, or because these sense organs in the bee are specially adapted for appreciating very low concentrations of stimulants. This fall-off in response soon ceases if the concentration of the repellent is further increased above a certain level, and this may be due to irritation of the common chemical sense of the bee. This argument is strongly supported by the results obtained when the test solutions are alternated with pure sugar syrup in time instead of space. Under these conditions there is a direct conflict between the stimulus inherent in the bee to collect food and the power of the chemical to act as an irritant and elicit an avoidance reaction. A much narrower range of concentrations is involved which still has the same concentration of 0·05 per cent as its upper limit. Although the same pattern of behaviour was always obtained, it was found that the concentration of phenol which was capable of repelling all the bees fluctuated with different colonies at different times of year between 0·04 and 0·2 per cent. It was also reported by Mr. Glynne Jones that he has observed bees which were flying over test solutions touching the surface of the liquid with the tarsi of their hind-legs, and suggested that perhaps these bear olfactory organs. At the close of his paper he showed a short film of some of his experiments.

The discussion which followed the afternoon papers was very brief and consisted of a few questions addressed to the speakers rather than a discussion on the behaviour of social insects.

CHEMICAL ENGINEERING

THE growing appreciation of the importance of chemical engineering was evident at the recent meeting in Belfast of the British Association, when Section G (Engineering) devoted a session to the subject of education and training in chemical engineering, at which, under the chairmanship of Sir Ben Lockspeiser (president of the Section), papers were presented by Prof. D. M. Newitt (Courtauld professor of chemical engineering, Imperial College of Science and Technology, London) on "The Training of Chemical Engineers", and by Dr. E. H. T. Hoblyn (director, British Chemical Plant Manufacturers' Association, London) on "The Chemical Engineer in Industry". The discussion was opened by Sir Harold Hartley (past president of the British Association and of the Institution of Chemical Engineers). The contents of the two papers, together with points from the discussion, are summarized in this article.

The rise of chemical engineering as a primary technology is one of the direct consequences of industrial and economic developments which are still taking place. It may be said to owe its origin to the big expansion in the heavy chemical industry and to the simultaneous growth of new industries, resulting from intensive scientific research during the latter half of the nineteenth century. There was at that time a growing conviction that empirical methods of plant design, based mainly upon trial and error, could no longer meet the needs for better process control and for higher operating efficiencies and would have to give place to more scientific procedures. George E. Davis, one of the pioneers of chemical engineering, first began to lecture on the subject in 1887, and his well-known "Handbook of Chemical Engineering" was published in 1901. The introductory chapters of this book should be studied by anyone in doubt as to the true functions of a chemical engineer.

The new branch of engineering, however, made slow progress in Great Britain and, as has so often happened, it was left to Germany and the United States to build up those renowned schools of chemical technology and chemical engineering which, during

the inter-war years, gave them such an outstanding lead in the international race for higher industrial productivity. In Britain we now have to face the task of recapturing some of the lost ground and, by increasing our facilities for higher technological education and vocational (technical) training, of making available to industry the skilled men required, at all levels, for the purpose.

But, in the interval, the problem has increased in scope and complexity. Technological, economic and social factors are now so closely interwoven in the structure of the modern State that higher technological education must aim at providing not only for the vocational requirements of the technical specialist but also that wider culture essential to those destined for leadership in industry and commerce. It is in this broader context that the training of chemical engineers should be considered.

There is a great deal of evidence to suggest that our industries have, over the course of years, lost the initiative in the development of new processes and products; and numerous examples might be quoted in which inventions and discoveries made by British scientific workers have been left for exploitation abroad. The growing practice of paying royalties to foreign competitors on this count is, in every respect, undesirable; not only is purchased 'know-how' always out of date, but also the practice denies to our technologists those opportunities for widening their experience and displaying their skill and initiative which are so necessary if we are to compete on level terms in the world's markets.

It was pointed out in the Dunsheath report on "Universities and Industry" (published by the Anglo-American Council of Productivity) that many Americans believe that their large numbers of chemical engineers have been an important factor in the rapid progress of industry in the United States. During 1949–50 the number of first degrees in chemical engineering in the United States was 4,529, to which must be added 712 master's and 178 doctor's degrees. It is doubtful if in Great Britain the output of chemical engineers from graduate and postgraduate courses will exceed 250 in 1953. Dr. Dunsheath's team was impressed by the importance attached to chemical engineering in the United States, and reported that this is a field to which American industry looks for a large and increasing number of its graduates. It is not too soon, therefore, that so much attention is being focused on the training of chemical engineers in Britain.

The objective of a chemical engineering training is, in the words of Prof. W. K. Lewis, "the development of the capacity of the student when faced with a new and unfamiliar situation, to handle it with a competence, involving skill, initiative and leadership". Industry must ensure that, when such men are available, opportunities are offered for the exercise of their talents.

The main types of work in which chemical engineers find employment in the chemical and allied industries, including the gas and oil industries, are research, development and design of plant; construction and installation of plant; process control and plant operation; plant maintenance. The nature of the work, the type of man employed and the level of qualification required all vary from job to job and from section to section of the industry.

Chemical plant manufacturers use chemical engineers for research and for designing and installing plant and handing it over to the customer in a satisfactory operating condition. Such work is fundamentally the same whether the plant is to be used in the chemical, gas or oil industries, and requires to be carried out by fully qualified men of high technical ability and preferably having had some plant-operating experience. The plant manufacturer also employs chemical engineers on his sales staff.

The chemical and allied industries employ chemical engineers in two very different spheres which require different levels of qualification. In the first place, the chemical industry uses them for research and development and the subsequent design and installation of plant for its own particular processes. This often involves the linking-up of specialist equipment supplied by a number of plant manufacturers. Such work may also include the costing of the plant and process and its comparison on technical and commercial grounds with an alternative process. A fully qualified chemical engineer is required for such duties, and he must be competent to work closely from the outset of the project, on one hand with the chemist who has evolved the process in the laboratory, and on the other with the civil, mechanical and electrical engineers who will be concerned with the erection and servicing of the plant and the structures which support it or the building which houses it. The chemical industry also employs chemical engineers for plant operation and process control. While large numbers are employed in this way, the number could, with advantage to productive efficiency, be greatly increased, if men with the right type of training were available in sufficient quantity; a lower level of training can normally be accepted for such work, for which chemical engineers with the Higher National Certificate (to whom reference is made later on in this article) should be admirably suited.

The oil industry and the gas industry, like the chemical industry, use chemical engineers for design and development work and for process control and technical supervision.

It is clear, then, that in the chemical and allied process industries and in the engineering industries which serve them there is tremendous scope for chemical engineers of varying levels of competence and inclination.

It has been pointed out that chemical engineering constitutes a distinctive discipline which embraces the whole of that body of applied science utilized in transferring a process from the laboratory stage to large-scale production; it is, in addition, concerned directly or indirectly with the economics of production and with the social implications of new scientific discoveries. The range of subjects to be covered is therefore extensive, and any endeavour to insist upon a high degree of proficiency in all the sciences included in the definition would be impracticable. A thorough grounding in the fundamental principles of the physical sciences is essential, but attention should thereafter be directed towards those special applications which constitute what are now generally known as the unit operations and unit processes of chemical engineering. In addition to this later study, as much of the groundwork training as possible should be carried out in the chemical engineering departments.

Any endeavour, therefore, to base a first-degree course in chemical engineering upon any synthesis of existing courses in chemistry, physics and mechanical engineering is unlikely to be successful. The only feasible compromise is that by which chemical engineering may be taken as a postgraduate subject

following upon a first degree in chemistry or mechanical engineering; this method, however, involves an additional one or two years of study and carries with it no very tangible compensating advantages.

The most significant advance which has been made recently in the scope of chemical engineering training in Britain is the establishment of Higher National Certificates in the subject; the courses to this level will be taken by students holding a National Certificate in chemistry or engineering.

Industry should welcome these new courses, which will produce what have already been described as the 'non-commissioned officers' of the chemical and chemical-plant industries, which must ensure that sufficient raw material is forthcoming from their ranks to warrant the establishment of Higher National Certificate courses in various centres. Industry must also ensure that it uses these 'non-commissioned officers' properly. First, they should be employed at a level of work suited to their training —in some cases this should enable better qualified men to be released for more responsible duties, while in others it should enable more chemical engineers to be used on duties for which at present they are sadly lacking, such as plant and process control, as mentioned earlier. Secondly, industry must provide the 'non-commissioned officer' with the incentive of promotion, where competent, to 'commissioned' rank.

From the educational point of view, one of the important problems common to all categories of technology is the emphasis which should be given to works experience as an integral part of a university training. The purpose of introducing a student to industrial life during his university career is to impress upon him at an early stage that this work has to form part of a complex structure, other component parts of which are labour and management and the economics of production; but nothing can replace the first-hand experience gained by direct contact with men and things.

Two alternative methods have been adopted to this end in Great Britain, one based upon vacation work and the other upon sandwich courses: in the former, the student is expected to devote some eight weeks of at least two long vacations to employment in a works; in the latter, more extended periods of employment are sandwiched between attendance at the university. There is not much to choose between the two, and both depend for their success upon the student being able to identify himself with the routine and life of the works and being given definite duties and responsibilities. In all circumstances, he will pick up something of value from such industrial contacts and, when the courses are carefully planned, the benefit he obtains is important and far-reaching.

In general, first-degree courses in chemical engineering extend over three post-intermediate years, the first two of which are devoted to the physical sciences and to certain branches of mechanical engineering and mathematics, and the final year to unit operations and processes. It cannot be held that such a short period is sufficient to enable any comprehensive syllabus to be covered in its entirety, and it is particularly important to guard against the dangers of introducing so much detail that the student fails to obtain a broad perspective of his subject. For this reason, an extension of the course to a fourth year, with all the formal apparatus of lectures, tutorials and examinations, is not altogether desirable. The atmosphere of impending examinations is not conducive to independent thought and inquiry; and, if we wish to foster and develop initiative and enterprise, there must be a period during which the student can, under direction, begin to apply his knowledge. In some respects, this end is attained by one or two postgraduate years devoted to original work. In the case of selected students the time so spent is undoubtedly of great value. The planning of a systematic piece of research, the devising of new experimental methods and techniques, the critical appraisal and discussion of results bring out qualities in a student which no system of examinations can hope to reveal. But it must be recognized that all students are not temperamentally or intellectually fitted for research work, and no useful purpose is served by forcing them to spend one or two years in a distasteful occupation.

If we remember, however, that the technologies aim at the application of fundamental principles to practical problems and at the introduction of new methods and techniques into industrial practice, it becomes possible to devise a postgraduate course which will entail investigations of a more practical character than those generally included under the heading of fundamental research.

There is no reason why such investigations should not, in suitable circumstances, be undertaken by teams of students rather than by individuals, and in co-operation with industry rather than in the isolation of a university laboratory. This matter has been referred to indirectly in the Cremer report on chemical engineering research (published by H.M. Stationery Office for the Department of Scientific and Industrial Research), which emphasizes the importance of the functional analytical approach to chemical engineering research.

As the result of such a system of training, the graduate should enter industry with a background of fundamental science, with some knowledge of industrial organization and with a sound understanding of the basic operations of chemical engineering. He will not be familiar with the practice of any one industry nor with those technical details of plant operation which can only be acquired by works experience; and it must be recognized that some time will elapse before he can be expected to make his full contribution as a technical specialist. He should, however, be competent, at the outset, to undertake design and development work and to bring to it those qualities of initiative, originality and adaptability which are so urgently needed in industry to-day.

It is appreciated by industry, however, that it must be prepared to train the graduate further after he leaves the university, and some firms in the chemical plant field and elsewhere have developed two-year trainee courses for chemical engineering graduates.

Finally, it will be evident that chemical engineering differs essentially from those technologies which are confined to the principles and practices of particular industries or of groups of related industries, and that the strong suit of chemical engineers is that they can, by the generality of their training, be regarded as a mobile force of technologists able to move from industry to industry as economic conditions dictate.

Engineers must therefore give their support to this fourth primary technology; it is complementary to the older technologies—not competitive with them—and must have a place in their team, for on such team-work so much of the future industrial prosperity of Britain depends.

THIRTEENTH INTERNATIONAL HORTICULTURAL CONGRESS

THE thirteenth International Horticultural Congress was held in London during September 8–15. It was opened on the morning of September 8 by Sir Thomas Dugdale, the Minister of Agriculture and Fisheries. Lord Aberconway, president of the Congress, and Dr. H. V. Taylor, vice-president and chairman of the National Organizing Committee, also spoke. Lord Aberconway particularly stressed the importance for horticulturists as well as for botanists of the stability of names of the more widely grown plants, and meetings of the International Committee on Horticultural Nomenclature and Registration were held every day throughout the Congress.

This was the first International Horticultural Congress since the one in Berlin in 1938 and, as befitted the times, the main theme of the Congress was the discussion of methods by which new developments in horticulture, plant breeding and the control of pests and diseases have raised and can raise further the world production of food and other economic crops. Each morning there were general lectures which were considered as being of wide importance to horticulturists, while in the afternoon the Congress divided into seven sections dealing with fruit growing, vegetable growing, ornamental plant growing, plant breeding, environmental control, seeds and tropical and sub-tropical horticulture, respectively. As far as possible, summaries of the general lectures and full copies of the papers prepared for sectional meetings were made available in advance to Congress members.

Throughout the Congress the reliance of modern horticulture on scientific research was stressed, particularly in the fields of genetics and cytology and plant physiology.

The role of climate and its influence on plant growth was discussed by Dr. F. W. Went, of the United States. In particular he described the modifications in various factors, such as temperature and humidity, which can be obtained by artificial means such as cultivation in greenhouses or against walls, and their effect on the plants cultivated, and was able to bring under a scientific scrutiny many traditional horticultural methods. Other aspects of this problem were discussed by Prof. Pierre Chouard, of France, and Dr. J. W. M. Roodenburg, of the Netherlands. Prof. G. E. Blackman, of Oxford, showed his methods for making an analysis of the effects of seasonal light intensity and temperature on the growth of plants in the vegetative phase with special reference to the English bluebell, *Scilla non-scripta* (*Endymion non-scriptus*), and the effects of shading on growth and development. He was able to show that for each plant it is possible to estimate the light intensity at which growth will be optimal. The control of photoperiodicity by practical methods and the effect of artificial lamps on growth were discussed by several speakers. Dr. J. W. M. Roodenburg showed that the low-tension neon lamp giving a red-orange light and the ordinary incandescent lamp were effective in increasing growth in periods of low light intensity such as the shorter days of winter. Radiation from the red end of the spectrum appears to be effective in promoting the flowering of many long-day plants such as sugar-beet, but retards flowering in the case of short-day plants. Prof. F. G. Gregory also gave a most interesting paper as a general background to recent physiological research in the control of growth and reproduction in plants by environmental factors.

Prof. K. Mather, of Birmingham, in a general lecture on the relation of genetics to plant breeding, gave some pointers for the production of new horticultural crop plants through polyploidy and other factors, such as the variation induced by the use of ionizing radiations like X-rays and by certain chemicals. He confessed, however, that we still have no clue as to how to produce direct mutations, or even as to whether this is possible. The importance of heterosis or hybrid-vigour was stressed by several other speakers, particularly by Dr. Gordon Haskell, and the effects were well shown by the hybrid strains of onion produced by Dr. H. A. Jones, of Beltsville, United States. In this section Dr. S. L. Emsweller, also of Beltsville, read a fascinating paper on developments in plant breeding due to the use of colchicine, a substance which, by inducing polyploidy, has opened the door to many interesting new combinations of genes. The effects of polyploidy on sterility were mentioned by several speakers, and this is obviously a subject which requires further study.

The section on fruit growing was a strong one, and Prof. T. Wallace, of Long Ashton, Bristol, gave an introductory general lecture entitled "Some Aspects of the Mineral Nutrition of Horticultural Plants". Prof. Wallace has made a special study of the effects of deficiencies of mineral trace elements in the cultivation of fruit, and this paper gave a valuable summary of a field of obvious interest and importance to the practical grower and one in which, once the correct diagnosis has been made, the cure can be effected with reasonable certainty. The work of the East Malling Research Station in Kent in standardizing root stocks for apples and pears is now well known and part of the common horticultural practice of the fruit grower; but Dr. Beryl Beakbane described some of the scientific reasons behind the effects of particular rootstocks in a paper on the anatomical structure in relation to rootstock behaviour, while Mr. A. P. Preston, also of East Malling, discussed some new apple rootstocks. The proportion of bark, that is tissues outside the cambium, to wood in the lateral roots of clonal rootstocks has been found to be related to the effect of the rootstock on the size of tree at maturity, rootstocks with a large amount of bark being the most dwarfing. Mr. Preston described a new series of apple rootstocks resistant to woolly aphid. These were bred jointly at East Malling and the John Innes Horticultural Institution, and more than twenty new rootstocks have been bred and selected out of 3,758 seedlings. Damage from spring frosts has proved one of the most difficult problems with which the grower of fruit in Britain has to contend. Dr. W. S. Rogers, also of East Malling, described the new technique of continuous water sprinkling for protection from frost, the main heating effect coming from the release of the latent heat of freezing, 80 calories per gram, as the water turns to ice. A precipitation rate of 6 mm. per hour was found to be the most effective and would protect most fruits from a temperature of 21·5° F. In this section one of the most interesting papers was given by Prof. H. B. Tukey, of the United States, in which he described the uptake of nutrients of the leaves and bark of fruit trees and the use of radioactive isotopes for following the nutrients through the tree. This treatment was shown to be effective also in winter when the tree appeared dormant.

In a combined session on plant diseases and purity of stocks, Mr. W. C. Moore stressed very strongly the importance of ensuring really healthy plant material before it is moved from country to country. The introduction of major pests with plant material is unfortunately only too well known and common an experience. Virus diseases are one of the most difficult problems that horticulturists now have to face, and in his paper on the serological diagnosis of plant diseases caused by virus, which he supported with a film, Prof. E. van Slogteren, of the Netherlands, showed how many virus diseases can at any rate be diagnosed by serological methods, a diagnosis which is independent of the symptoms of the plant.

A paper of great interest on the use of 'Krilium' as a soil conditioner, by Dr. A. J. Lloyd and Dr. C. E. Morgan, of Monsanto Chemicals, Ltd., was presented in this session, and a film was shown demonstrating the power of 'Krilium' to retain a crumbly soil structure and for the treated soil to retain drops of water without disintegrating. 'Krilium' was described by the authors as "a new synthetic polymeric electrolyte of a resin type, which by reason of its high anion potential, possesses large numbers of reactive groups in the molecule". It is understood that tests are proceeding in Great Britain, and it is to be hoped that soon this material, which is already on the market in the United States, will also be available in Britain.

In a Congress to which more than a hundred different papers were presented by speakers from twenty-seven different countries, it is obviously impossible to do more than touch on a few of the aspects of the very varied mass of material which was available. The report of the Congress will be published through the Royal Horticultural Society, Vincent Square, London, S.W.1, in due course.

In the field of the nomenclature of horticultural plants, a revised International Code was worked out during the Congress and will shortly be published as an interim code prior to submission to the next Horticultural Congress, which it is anticipated will be held in Holland in 1955 or 1956. The Congress also laid great stress on the importance of the registration of the names of cultivated varieties, and in a resolution recommended that an International Registration Authority should be set up as soon as practicable for each genus or group of genera in which cultivated varieties are numerous. The Congress also passed unanimously two resolutions on nomenclature for transmission to the next International Botanical Congress. It put on record that it was "strongly of the opinion that the interest of increased stability in the nomenclature of cultivated plants would be served by incorporation into the International Code of Botanical Nomenclature of the proposals for *Nomina Specifica Rejicienda* set out in Taxon I, No. 5 (1952) and urged their adoption at the next International Botanical Congress". It also recommended in a resolution that any provision of this nature should "allow for the rejection of certain earlier homonyms as well as earlier synonyms, and while appreciating the technical difficulties involved, urged the appropriate botanical authorities to make every effort to overcome them". Mr. J. S. L. Gilmour, director of the Cambridge Botanic Garden, was appointed chairman of the International Committee for the Nomenclature of Cultivated Plants.

Other resolutions of the Congress were passed (1) in favour of the establishment of a horticultural bureau in the Food and Agriculture Organization; (2) in support of the recommendations of the International Plant Protection Convention and for increased facilities for the exchange of experimental material between country and country; (3) in support of the encouragement of research into the fundamental problems of plant physiology; and (4) for the setting up of a small working party for considering an international method for recording light values on the lines of the Dutch Committee.

Patrick M. Synge

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

For the sixth year in succession the Chemical Research Laboratory, Teddington, of the Department of Scientific and Industrial Research, held a series of open days to which the director invited representatives of industry, universities and government departments. This year the open days were during September 23–26, and the attendance at all sessions indicated that there is no slackening of interest in this annual event.

A special feature this year was the new radiochemical building which has been specially designed and constructed, under the supervision of the Ministry of Works, for work with radioactive materials. It incorporates many modern features which make it one of the finest of its kind in Great Britain both for work with radioactive materials and for general chemical research. This building, with its associated pump house and tank farm, occupies an area of some twelve thousand square feet sited about a hundred yards from the main Laboratory block and is constructed of red brick with stone facing to conform to other buildings in the area. It comprises administrative offices, laboratories, plant room and service void, and pump house and tank farm. The administrative offices form a single-story section near the main entrance to the building and comprise an entrance hall, offices, conference room (also used as staff room), and cloakrooms which are provided with special facilities for changing and washing.

The main part of the building consists of two large laboratories and a number of smaller rooms divided, in part, by a central passage. Immediately beyond the cloakrooms and on one side of the passage are two laboratories concerned with research on the application of ion-exchange resins to the separation of metals. In these rooms an exhibit showed the development of a method for separating gold from other metals, such as iron, copper, silver, nickel, cobalt and zinc, in cyanide solution by an anion-exchanger. In this process, gold is removed from the resin by eluting with a mixture of acetone and hydrochloric acid. The other metals are eluted with aqueous solutions of salts such as sodium cyanide and potassium thiocyanate.

On the opposite side of the passage from the foregoing laboratories is a suite of rooms dealing with the measurement of radioactivity and allied topics. These laboratories comprise a counting room completely screened from electrical interference, a main

laboratory for the measurement of carbon-14 (including apparatus for low-activity measurements and a microscope for scrutinizing tracks on photographic plates), and a dark-room showing apparatus for the determination of radioactivity by measurement of scintillation in a liquid medium using solutions of *p*-terphenyl as the scintillator for radioactive material. A number of other items used in measurements of activity were shown in an adjoining laboratory.

Beyond the rooms already mentioned is a group of small laboratories and rooms. These laboratories, which can also be used as offices, are designed for one worker or for special purposes. Exhibits shown in two of these rooms included an automatic resin-life tester for determining how long an ion-exchange resin will stand up to continual re-use, and an apparatus for the continuous determination of metals by a polarographic method. Two further rooms contain balances and physical apparatus used in analytical work. Of special note is a nephelometer for turbidimetric determination. Beyond these small rooms is a large analytical laboratory containing eight double-benches, ancillary fume-chambers, dry benches for furnaces, washing-up sinks and built-in desks down each side of the laboratory. This laboratory deals with analyses of minerals and ores and with research on analytical methods. An exhibit of chromatographic methods using paper strips and columns was shown here, and particularly noteworthy was the method developed for determination of niobium and tantalum in minerals, ores and other substances. A small adjoining laboratory is devoted exclusively to fluorimetric methods, while a larger room is concerned with the separation of metals on paper strips using radioactive tracers, which are detected and determined on a special scanner built in the Radiochemical Group for this purpose.

The rest of the laboratory space is used for research work on the extraction and recovery of valuable metals from minerals and ores. A large room is available for operating with larger quantities of material than is possible in an ordinary laboratory. This large laboratory contained exhibits dealing with ion-exchange methods, precipitation under *p*H control and other techniques. Associated with this work are three smaller laboratories for research and control work, and a grinding room. The grinding room includes an ore storage annexe and contains a ball mill, hammer mill, mechanically operated screens, and an electromagnetic separator for preliminary ore treatment. This room is provided with a separate ventilation system to guard against hazard due to dust.

The plant room contains the machinery for ventilation and other items. Incoming air is filtered, washed and warmed before passing to the laboratories. Air is extracted through the fume chambers in the laboratories and passes through an electrostatic precipitator before ejection to the atmosphere through a 60-ft. chimney. This ventilation system is designed to provide at least 80 linear feet of air a minute through the fume chambers. A service void forms a second story to most of the building, and houses all the ducting and services. It provides a very colourful but orderly sight, and repairs can be carried out with minimum disturbance to the laboratories underneath.

The disposal of liquid effluent has also been carefully considered. All liquid waste from the laboratories passes through polythene piping to one of three stainless-steel delay tanks (500 gal.), where it is monitored for radioactivity. The liquid is then either left to allow time for activity to decay while the other two tanks are used, or pumped to one of two larger tanks (5,000 gal.) for dilution, or pumped directly to the drain, depending on the activity present. Provision is also made for chemical treatment in the smaller tanks and disposal by tank truck if necessary.

In the Corrosion Group of the Chemical Research Laboratory, work on the high-temperature corrosion of steel has been supplemented by a new research on oxidation by flue gases; this is intended to assist in the development of a ferritic steel suitable for boiler superheater tubes operating at temperatures above the present normal maximum. The apparatus used consists of a tubular furnace in which the weight increase of several specimens can be measured *in situ*.

An interesting exhibit was an automatically controlled apparatus of the weatherometer type for accelerated corrosion testing. Constructed of 'Perspex', this permits continuous or intermittent exposure of specimens to spray (simulating either industrial or marine atmospheres) and infra-red and ultra-violet radiation as desired. A recently recognized ('filiform') type of corrosion which appears as worm-like tracks on plain or lacquered steel plates is being investigated; examples produced in the laboratory were exhibited. The mechanism of corrosion inhibition by sodium benzoate and potassium chromate is being studied by radioactive tracer methods and by electrode potential decay curves. The practical application of inhibitors has been extended by the formulation of corrosion-inhibitive greases and thixotropic pastes. In electrochemical studies of paint films on immersed steel, special attention has been given to the estimation of the amount of water absorbed by the paint.

The Pure Metals Committee of the Chemistry Research Board continually collects and examines information on the availability of metals of high purity and, in addition, carries out analyses of such materials. In certain cases samples of the purest obtainable metals are kept in stock, and these can be made available to workers in other laboratories for their researches. At present twenty-three metals are kept, twenty-two of which were shown in the exhibit of the Inorganic Group. Also on view were samples of highly pure germanium and germanium dioxide in which the arsenic content had been reduced to one part in 10^8–10^9. These were purified by a process developed in the Laboratory and for which a patent application has been made. The process of purification has been studied by the use of radioactive arsenic.

Results of investigations on the production of fertilizers have been published and communicated to the industry. Further work in this field is confined to some more-specialized aspects, notably a study of the production of dicalcium phosphate. A wide range of equipment was shown in the microanalytical and spectrographic laboratories, including apparatus for the determination of active hydrogen by means of lithium aluminium hydride and a spectrum projection comparator.

One of the direct services of the Organic Group of the Laboratory to industrial and other laboratories is the supply of extremely pure organic compounds as standards for the calibration of mass spectrometers and for ultimate reference in other physical methods of analysis. Samples of thirty-six such standards

were shown which are all available on request. Recent advances in chemotherapy have emphasized the potential importance of certain of the homologues of pyridine, and special attention has been given to the devising of methods for their recovery from crude-tar bases, and to the establishment of suitable analytical techniques. Jointly with the Physics Division of the National Physical Laboratory, a study of the thermochemical properties of pyridine homologues has been started.

Preparative work of the Organic Group has included the synthesis of a supply of a cinnolylguanidine derivative (at the request of the Medical Research Council) for large-scale trial as a trypanocide, applications of the Kolbe–Schmidt reaction, and new syntheses of organic compounds containing isotopic carbon. Use of naphthalene labelled with isotopic carbon has been made in a method of estimating the naphthalene content of tar oils. The method would be suitable for use in studies of the effectiveness of naphthalene extraction in large-scale processes.

In the High Polymers Group, work on semi-permeable membranes and ion-exchange resins was shown. The behaviour in non-aqueous systems of membranes prepared from polyvinyl alcohol is of outstanding interest. Using membranes of this type, polymer molecular weights from one million to two thousand have been determined by osmometry; in no case was there evidence of solute diffusion through the film (*J. Chem. Soc.*, 3190; 1952). Statistical analysis of the results has shown that the relationship between osmotic pressure and concentration is best satisfied by the equation, $\pi = aC + bC^2$, where a and b are constants. Simple osmometers (capacity about 3 ml.) based on the Zimm–Meyerson design have been constructed for use with polyvinyl alcohol membranes. A novel form of reversed-phase partition chromatography was exhibited. Cross-linked polystyrene beads are allowed to swell in a carbon tetrachloride solution of the water-insoluble complexing agent, for example, dithizone. The swollen beads behave as selective absorbents and may be used for the recovery and separation of metals from aqueous acid solution.

Another service of the Chemical Research Laboratory is the supply of bacterial cultures of industrial and research interest. The National Collection of Industrial Bacteria, within the Microbiology Group, now maintains some six hundred strains, most of which are preserved in the freeze-dried state. Methods of classification and maintenance were demonstrated. Responsibility for the maintenance of 'official' cultures of antibiotic-producing organisms has recently been assigned to the National Collection by the United Nations World Health Organization.

Fundamental research on the sulphate-reducing bacteria has included a study of their oxidation of lactic, malic, pyruvic and other acids with sulphate as oxidizing agent, and the discovery of a 'sulphate-free' fermentation leading to ethanol and acetic acid. Work on their utilization of hydrogen has shown that this can result in the reduction of fumaric to succinic acid. Evidence for a co-hydrogenase, replaceable by methylene blue, has been obtained. Investigations on the microbiological production of sulphur and sulphide from sulphate are in progress at the Laboratory and at the Microbiological Research Department (Ministry of Supply) at Porton. At the latter station, a continuous method of bacterial sulphate-reduction is being used; photographs and a diagrammatic flow-sheet of the apparatus used were exhibited.

OBITUARIES

Prof. C. H. Lees, F.R.S.

Prof. C. H. Lees passed away on September 25, at the age of eighty-eight. He was a man of great charm and endeared himself to friends and students. Lees possessed great patience, and he was not to be deviated from the course he had set himself by difficulties when carrying out a piece of research.

Born in Glodwick, Oldham, in 1864, he was a student at the Owens College, Manchester, becoming Berkeley Fellow in 1888. He then studied at the University of Strassburg.

In 1891 Lees was appointed senior assistant lecturer and demonstrator in physics in Owens College and became lecturer and assistant director of the Physical Laboratories of the University of Manchester in 1900. He left Manchester in 1906 to become professor in Queen Mary College, where he remained until 1930, retiring with the title of emeritus professor of physics in the University of London.

Although Lees's first claim to fame lies in the field of thermal conductivity measurements, he was a man of wide interests. In the years between the two World Wars, he had students carrying out research on problems of acoustics, elasticity, light, electricity, as well as heat. He contributed papers on A.C. bridges and on fluid flow through pipes. The technique he used in thermal conductivity measurements now finds a place in the text-books. His *Phil. Trans.* paper on the thermal conductivity of metals to low temperatures was the subject for 1908 of the Bakerian Lecture of the Royal Society.

Lees was an excellent committee man and for more than twenty years served on the Engineering Committee of the Food Investigation Board of the Department of Scientific and Industrial Research. He also served on the Safety in Mines Board.

Education was a topic of great interest to him and for a long period he served on the Kent Education Committee and the delegacy for managing Goldsmiths' College, London. For a time he was vice-principal of Queen Mary College. He served as president of the Physical Society and vice-president of the Institute of Physics.

His hobby was handicrafts, and up to within a few days of his death he occupied his time with carpentry.

In the passing of C. H. Lees we mourn the loss of one of the 'old guard' of physics of the past generation and one of the greatest of friends.

Ezer Griffiths

Prof. Millais Culpin

It is with regret that we record the death on September 14 of Prof. Millais Culpin at the age of seventy-eight. He was one of the brilliant group of psychiatrists revealed by the First World War.

He studied at the London Hospital and qualified M.R.C.S., L.R.C.P. in 1902, passing the F.R.C.S. three years later. It seemed that he was prepared for a surgical career and, indeed, he practised this for a time at Shanghai. However, when the War broke out, he joined the R.A.M.C. and became interested in war neurosis. Then he served in France during 1916 and 1917 as a surgeon, but still retained his psychiatric interest. At the end of this time he was asked by Aldren Turner to work in the Army neurological hospitals and there found ample material for research. His M.D. thesis in 1919 was devoted to his findings,

and the following year he published his "Psychoneuroses in War and Peace".

Culpin was then appointed lecturer in psychiatry to the London Hospital Medical School and neurological specialist to the Ministry of Pensions. In 1923 he joined in research on neurosis organized by the Industrial Health Research Board and in 1930 was made lecturer in psychology to the London School of Hygiene and Tropical Medicine. The year after, he was appointed to the chair of medical and industrial psychology, which he occupied until he resigned in 1939.

He had a remarkably lucid mind and often was able to see things from an unusual angle. His spare dry wit occasionally illuminated his points. His writing, also, showed his clear, logical thought. He published a number of books, including "Spiritualism and the New Psychology", "The Nervous Patient", "Medicine and the Man", "Mental Abnormality: Facts and Theories", and, in collaboration with Dr. May Smith, "The Nervous Temperament". His best known work was "Recent Advances in the Study of the Psychoneuroses", which summarized all the work up to its publication in 1931.

Prof. Culpin was never a spectacular figure; but he leaves behind a solid basis of research and exposition which has earned him a place among the pioneers of dynamic psychology in Great Britain.

CLIFFORD ALLEN

NEWS and VIEWS

Institution of Mining and Metallurgy: New President

PROF. J. A. S. RITSON, professor of mining in the Royal School of Mines, London, has been elected president of the Institution of Mining and Metallurgy for the session 1953–54 and will take office at the general meeting to be held on May 28, 1953. Prof. Ritson was educated at Uppingham School and in 1910 took his B.Sc. in mining at the University of Durham. He acted for a time as manager of a colliery in Northumberland and then became an inspector of mines. In 1923 he was appointed to the chair of mining in the University of Leeds, where he remained until he went to the Royal School of Mines in 1935, in which year he was awarded the O.B.E. Prof. Ritson served throughout the First World War, eventually commanding a battalion of the Royal Scots, and gained the M.C. and D.S.O. and bar. During the Second World War he was director of supplies at the Ministry of Fuel and Power until the middle of 1942. Prof. Ritson is a past president of the Institution of Mining Engineers.

Illuminating Engineering Society: New President and Awards

AT the opening sessional meeting of the Illuminating Engineering Society held on October 14 at the Society's headquarters at 32 Victoria Street, London, S.W.1, Dr. W. J. Wellwood Ferguson took office as president of the Society for the session 1952–53. Dr. Ferguson, who is senior ophthalmic surgeon at the Royal Infirmary, Sheffield, and lecturer in ophthalmology in the University of Sheffield, is one of the relatively few ophthalmologists who take an interest in lighting and is the second of his profession to become president, the first being Sir John Parsons, who held the office during 1921–23. One of Dr. Ferguson's particular interests in lighting matters is the illumination of mines and miners' nystagmus, and he has published numerous papers on these subjects. He is the only ophthalmologist who takes an active part in the meetings of the International Commission on Illumination, and he serves on a number of subcommittees of the National Illumination Committee and on the Light and Vision Committee of the Medical Research Council. Recently, he visited the United States to study the work being done there in the use of cortisone in connexion with certain diseases of the eye.

The Leon Gaster Memorial Premium of the Society for 1952 has been awarded to Mr. J. S. McCulloch for his paper on "The Lighting of Shipyards"; Mr. McCulloch is with R. W. Gregory and Partners (consulting engineers) of Newcastle upon Tyne. Honorary membership of the Society has been awarded to Prof. J. T. MacGregor-Morris, professor emeritus of electrical engineering in the University of London, in recognition of his many services to the Society and in acknowledgment of his pioneering work in illuminating engineering and photometry, particularly his research on the carbon arc as a standard of light; Prof. MacGregor-Morris is one of the original members of the Society and was president in 1940.

The Biological Council

THE Biological Council, which is composed of representatives of some fifteen specialist biological societies, has recently resolved to become an advisory body to the Institute of Biology. It is expected that the closer relations between the Council and the Institute—formed on the initiative of the Biological Council—will be mutually beneficial. At a meeting of the Biological Council held on September 29, the following officers were elected: *Chairman*, Dr. W. P. K. Findlay (Forest Products Research Laboratory, Princes Risborough, Bucks); *Hon. Treasurer*, Prof. F. L. Warren (London Hospital Medical College); *Hon. Secretary*, Dr. J. L. Cloudsley-Thompson (Department of Zoology, King's College, University of London). All communications should be addressed to Dr. J. L. Cloudsley-Thompson, c/o The Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.2.

Technological Education in Manchester

AT a ceremony on October 11 at the College of Technology, Manchester, which formed part of the jubilee celebrations of the College, the associateship of the College was conferred on the Minister of Education, Miss Florence Horsbrugh, and on Lord Cherwell and Alderman Wright Robinson. Although more than one speech emphasized the dependence of the economic future of Great Britain upon technicians and technologists, Miss Horsbrugh made no reference to the Government's plans for the expansion of higher technological education. She assured her audience that the claims of the Manchester College of Technology had been very fully presented to her, and that she would do her best to meet the needs of both university and non-university work there. She could not say how quickly the Government could carry out developments which would lead to a major change in the character of the College. Lord Cherwell referred to the increasing

need for well-trained technologists, but also gave no indication of the Government's plans. Mr. David Cardwell, the acting principal, referred to the way in which uncertain financial backing had led to students having to abandon advanced courses before completion and urged the necessity of an extension of grants for postgraduate research. Mr. Cardwell also referred to the high quality of the part-time students and the potentialities of such students for increasing the supply of university graduates in science and technology. The City Council, he said, is pressing forward with a building programme for the College which would cost some £1,600,000.

International Nutrition Congress

The second International Congress of Nutrition, held under the auspices of the International Union of Nutritional Sciences, has just concluded at Basle. At a meeting of the Executive Committee of the Union, attended by representatives from sixteen nations, it was unanimously decided to accept the invitation of the Netherlands members to hold the third International Congress in Amsterdam in the summer of 1954. Prof. E. J. Bigwood (Brussels) was re-elected chairman of the Committee and Dr. Leslie J. Harris (Cambridge) honorary secretary. The following national, or organizational, representatives served on the Committee: Prof. E. J. Bigwood (Belgium), Dr. Morley Whillans (Canada), Prof. H. Dam (Denmark), Prof. A. I. Virtanen (Finland), Prof. E. Terroine (France), Prof. H. Kraut (Germany), Dr. M. Demarchi (Iraq), Dr. F. Mancini (Italy), Dr. A. Seliskar (Jugoslavia), Dr. M. van Eekelen and Prof. B. C. P. Jansen (Netherlands), Mrs. B. Q. Werenskiold (Norway), Prof. E. Abramson (Sweden), Prof. K. Bernhard and Prof. F. Verzár (Switzerland), Mr. A. L. Bacharach and Dr. L. J. Harris (United Kingdom), Dr. S. G. Greenberg (U.S.A.), Dr. W. R. Aykroyd (Food and Agriculture Organization), Dr. T. Norris (World Health Organization), Dr. D. P. Cuthbertson (Scottish Group, Nutrition Society), Miss D. F. Hollingsworth (International Dietetic Congress).

Regeneration and Re-afforestation

In *Forestry Abstracts*, Vol. 12, No. 4 (Commonwealth Forestry Bureau, Oxford, June 1951), under "Sylviculture", F. C. Hummel describes "The Sylviculture of Mixtures in some Forests in S.W. Germany". The general policy, as contrasted with the almost universal habit in Germany during the past century and before of pure coniferous crops, is now to grow conifers and broad-leaved species in mixture. This involves what is almost a revolution in sylvicultural and management methods, and the possibilities of applying them under British conditions are described. In discussing the degree in which artificial assistance is given to this new regeneration, it is mentioned that beech and other broad-leaved species are often transplanted when 4–6 ft. high; but it is necessary to prune both the roots and crowns of such large plants and to stake them. The method is not new. In the old days, when the Forest of Dean was resown with acorns, the practice was to put in at every 20 ft. or so an oak transplant of 4–5 ft. in height. The method is employed by the French in the tropical rain-forest of the Ivory Coast in West Africa. In re-afforesting work, transplants 1½–2 m. in height are used. P. Dineur discusses the ecology of *Quercus sessiliflora* (*Q. petræa*); measurements of light under various degrees of canopy closure were undertaken for seedling regeneration, using a photometer of photoelectric cell type. Sylviculturists have for years advocated the possibility of being able to ascertain the more-or-less exact light requirements of seedlings under overhead canopy. It looks as if data on this problem may be obtainable. Lessons long since learnt in India are discussed by T. S. Serevo on "Silvicultural Observations in Cut-over Areas in Ajusan, Philippines". Logging was undertaken in an over-mature Dipterocarp forest with sparse advance growth. It is impossible to remove the main stand in such a type of forest without destroying all the undergrowth, since with the removal of the canopy the forest floor dries up. The dangers of logging in tropical forests are pointed out. The lesson was learnt in Madras in the years following the First World War, when attempts were made to introduce Canadian and American methods of logging into the evergreen forests. The result was a failure and a considerable pecuniary loss. But the lesson was learnt once and for all for India. The breaking of the overhead canopy exposes the moist soil below, never before exposed, to heat, heavy rain and wind, and it is quickly dissipated; the area is then useless for agriculture and difficult to re-afforest.

National Foundation for Scientific Research, Brussels: Annual Report for 1950–51

The twenty-fourth annual report of the National Foundation for Scientific Research, Brussels (pp. 193; 1951), covering the year 1950–51, refers to the establishment on July 26, 1951, of the Inter-University Institute of Nuclear Sciences and to the increase of its financial resources from 20 million to 25 million francs. The Atomic Energy Commission has also since established, on April 9 this year, a Centre of Studies for the Application of Nuclear Energy, which, mainly under academic direction, will be responsible for the utilization of the products of the Belgian nuclear reactor. A list of publications of the nuclear physics centres at Brussels and Louvain during 1947–51 is included; work at the Ghent centre has included technological research on the preparation of graphite and metallic uranium and on photographic emulsions, and at the Liège centre on absorbent media for gamma-rays and neutrons, the application of photographic emulsions, nuclear chemistry and the construction of a high-tension generator of the Panthenier type. During 1951–52 the Foundation has distributed sixty subsidies, totalling 3·2 million francs and including contributions towards the cost of construction of an electronic calculating machine, an oceanographic research station at La Rochelle-Pallice, an insectarium at Mentone, an epigraphic and archæological survey of the two provinces of Nejran and Hasa in Saudi-Arabia, the construction of a heliostat for the scientific station of the Jungfraujoch, for excavations at Alba Fucens, for studies on the performance of gas turbines, and for studies of the radiation of the night sky at Arosa Observatory in co-operation with the High-Altitude Research Centre at Pasadena. Details of the distribution of radioisotopes in Belgium are included in the report, to which are appended lists of recipients of grants for 1951–52 and of papers by recipients of grants published during 1950–51.

Human Relations in Industry

The report of the conference on human relations in industry, arranged by the Ministry of Labour and National Service during March 18–20 (see *Nature*, 169, 872; 1952), has now been published (pp. 128;

London: H.M.S.O., 1952; 3s. 6d. net). It includes the text of the Minister's opening address, Sir George Schuster's address on the work of the Panel on Human Factors in Industry; Sir Cuthbert Clegg and Mr. T. Williamson's comments on the work of the Anglo-American Council on Productivity; and reports of the discussions, together with the final text of the four group reports on, respectively, the opportunity to work, the capacity of workers, wastage of man-power and the will to work. Appended to the report are the papers on these subjects issued for discussion at the conference, and the paper summarizing the findings of the industrial productivity teams of the Anglo-American Council on Productivity relating to subjects on the agenda of the Conference; also included is Sir George Schuster's memorandum on conclusions drawn from the projects sponsored by the Schuster Panel on Human Factors in Industry.

Durban Museum and Art Gallery: Annual Report for 1950–51

THE report of the Durban Museum and Art Gallery for 1950–51 is the last issued under the directorship of Mr. E. C. Chubb, who has so ably controlled the remarkable progress of this institution for forty-one years. Occasion is thus taken in the report to review this long period, which is shown to be one of continuous growth accompanied by increased popularity and educational value, limited only during the past few years by restricted accommodation. Unfortunately, although a new building embodying more adequate accommodation has been advocated during the past fourteen years, circumstances resulting from the Second World War have prevented its realization.

University College of North Staffordshire: Appointments

THE following appointments in the University College of North Staffordshire have recently been made: *Senior Lecturer*, Dr. A. M. Macbeath (mathematics); *Lecturers*, Dr. Monica M. Cole (geography), Miss Ruth M. Badcock and R. L. Plack (biology), Dr. D. J. O'Connor (philosophy), Mrs. P. Elizabeth Perrott (education), Dr. A. Fröhlich and B. Noble (mathematics), Dr. G. F. Smith (chemistry), and A. H. Oliffe (psychology); *Assistant Lecturers*, A. Hunter (economics), W. M. Williams (geography), Dr. S. C. Nyburg (chemistry), Miss Helga M. T. Frankland (biology), and P. H. Shelford and A. F. Trendall (geology).

University of Birmingham: Appointments

THE following appointments in the University of Birmingham have recently been announced: *Lecturers*, R. D. Mackey (civil engineering), K. M. Brown and W. G. Thomas (mining); *Research Fellows*, Dr. L. A. Radicati and Dr. J. G. Valatin (mathematical physics), J. J. Pick (Lucas Research Fellow in industrial metallurgy), and B. E. L. Deckker (James Watt Research Fellow in mechanical engineering).

British Society of Rheology: Members of Committee

AT the recent annual general meeting in Southampton of the British Society of Rheology, members of committee were elected as follows: *President*, A. G. Ward; *Secretary*, A. P. Feltham (British Iron and Steel Research Association, 140 Battersea Park Road, London, S.W.11); *Treasurer*, Dr. J. G. Oldroyd; *Editor*, A. A. Milne; *Northern Representative*, L. Grunberg; *Midland Representative*, A. W. Richardson; *Ordinary Members*, D. W. Jopling, Dr. J. W. S. Mardles and N. Wookey.

Announcements

THE autumn provincial meeting of the Physical Society will be held in the Physical Laboratories of the University of Manchester during December 18–19. The meeting will be on "Ionization Loss by Relativistic Particles" and will include speakers from the Atomic Energy Research Establishment, Harwell, and from the Universities of Bristol, Brussels, Glasgow, Leeds and Manchester. Non-members are welcome to attend. Details of the programme and application forms can be obtained from the Offices of the Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

To mark the opening earlier in the year of the Texile Institute's new headquarters at 10 Blackfriars Street, Manchester 3, a series of inaugural lectures is to be given there, the speakers and their subjects being as follows: October 24, Sir Ben Lockspeiser (secretary of the Department of Scientific and Industrial Research), on "Science in Industry"; November 21, Sir Wallace Akers (a director of Imperial Chemical Industries, Ltd.), on "The Chemical Industry and Textiles"; and January 30, Mr. A. H. Wilson (research director of Courtaulds, Ltd.), on "Whither Man-Made Fibres?". Each lecture will commence at 3 p.m. Admission is by ticket, applications for which should be made to the Registrar of the Institute at the above address.

THE twelfth series of postgraduate lectures organized by the Oil and Colour Chemists' Association will be given by Prof. C. E. H. Bawn, professor of inorganic and physical chemistry in the University of Liverpool, who will speak on "Autoxidative Reactions: their Chemistry, Mechanisms and Catalysis by Metal Salts". The lectures will be given at 6.30 p.m. on November 17, 24 and December 12 in the Lecture Theatre of the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1. The fee for attendance is 15s. for members of the Association and £1 for others (inclusive of a copy of the lectures). Further information can be obtained from the Association at Memorial Hall, Farringdon Street, London, E.C.4.

THE Medical Research Council invites applications for the Kathleen Schlesinger Fellowship, tenable initially for one year at the National Hospital for Diseases of the Nervous System, Queen Square, London, and worth £700–1,000 a year. This Fellowship is provided from a fund established by the late Mr. and Mrs. E. M. Schlesinger in memory of their daughter; it is for the investigation of the origin and nature of cysts of the brain, and preference will be given to candidates who elect to work on the mechanisms underlying degenerative processes affecting the brain. Applications must reach the Secretary of the Medical Research Council, 38 Old Queen Street, London, S.W.1, not later than November 15.

THE University of Chicago, with the financial support of the Rockefeller Foundation, is offering three postdoctoral fellowships in statistics for 1953–54. These fellowships, which are worth 4,000 dollars each, are open to holders of a doctorate or its equivalent in research accomplishment, and their purpose is to enable research workers in the biological, physical and social sciences to acquire training for the application of statistical methods to their normal work. Details of application (to be completed by February 3, 1953) and further information can be obtained from the Committee on Statistics, University of Chicago, Chicago 37.

HUMAN BIOCHEMICAL GENETICS

A JOINT SESSION arranged by Sections D (Zoology), I (Physiology), J (Psychology) and K (Botany) of the British Association was held during the recent Belfast meeting to discuss "Human Biochemical Genetics".

In his introductory remarks, Prof. L. S. Penrose (Galton Laboratory, University College, London) pointed out that the foundations of the exact study of human genetics were laid down almost simultaneously by Landsteiner in his work on the *ABO* blood groups and by Garrod in his work on alkaptonuria. These investigations, carried out between 1900 and 1902, described human characters which were found to follow simple rules of inheritance, and the tests for their presence or absence were precise. The branch of the subject initiated by Landsteiner utilized serological techniques depending ultimately, but not yet demonstrably, upon inborn biochemical peculiarities. The other branch of biochemical studies in human genetics is derived from Garrod's work, and it deals with characters identified by ordinary chemical tests or their equivalents, like colour reactions.

It is convenient to classify the known types of inborn biochemical specifications by the substances involved in the test reactions. Anomalies of protein metabolism include alkaptonuria, the amino-aciduria, such as phenylketonuria, tyrosinosis, cystinuria and beta-amino*iso*butyricaciduria (the 'T-pattern' described by Crumpler, Dent, Harris and Westall), the melanin peculiarities exemplified by albinism and the globulin specificities found in the blood in sickle-cell trait and thalassæmia. Abnormal lipoid metabolism is represented by such diseases as xanthomatosis and cerebromacular degeneration; at present this group has proved intractable for experimental investigation. Anomalies associated with carbohydrate metabolism include pentosuria, fructosuria and renal glycosuria; diabetes mellitus is only included in a very indirect manner. There is also a large miscellaneous group of conditions, not easy to classify, some associated with disease and others quite harmless; for example, gout, porphyria, congenital methæmoglobinæmia, red hair and taste deficiency.

A primary aim in human genetics is to reduce all characters so far as possible to chemical differences. In this way, the study of human constitution will gradually become an exact science freed from ambiguities and superstitions which surround the cult of physical types. Moreover, with harmful traits, knowledge of the causal mechanisms can help in planning their alleviation or cure.

Three aspects of the subject were emphasized by Dr. H. Harris (University College, London): the precise characterization of human variations in biochemical terms, the genetical analysis of traits so defined, and the study of the processes by which individual genes produce their particular effects. These points were illustrated by reference to amino-acidurias in general and especially to cystinuria, a condition first recognized by Wollaston in 1810 on the discovery of a renal stone of unusual composition. Since the introduction of paper chromatography, it has been possible to separate a classical type of cystinuria, in which cystine excretion is accompanied by excessive excretion of lysine and arginine, from other types, in which it occurs as part of a generalized amino-aciduria (for example, Fanconi syndrome, Wilson's disease). Quantitative studies using the technique of polarography were carried out in families containing cases of classical cystinuria. Those with stone formation were found to excrete on the average about 750 mgm. of cystine daily, whereas normal people averaged about 60 mgm. In one group of families studied, cystinuria segregates sharply and behaves as a single Mendelian recessive trait. In the remainder of families, three distinct types of individuals were found: the data here were consistent with the hypothesis that heterozygotes (carriers of the gene causing cystinuria in homozygotes) excreted about 150 mgm. daily and were thus distinguishable from normal homozygotes. The frequency of carriers of this incompletely recessive gene is about 3 per 1,000 in the general population.

Garrod's view on the causation of biochemical anomalies was that there was congenital absence of an enzyme concerned in performing a particular step in metabolism. This theory is easy to apply to alkaptonuria and phenylketonuria; but in renal glycosuria or cystinuria the process is not so clearly demonstrable. A block in intermediate metabolism would tend (as it does in phenylketonuria) to cause an increase of unusable metabolites in the blood-stream or tissue-fluids. This does not occur in classical cystinuria, and it is thought that there is failure of reabsorption in the kidney tubules due to a defect in one of the chemical reactions concerned in this complex process.

A detailed account of the effects of the recessive gene for phenylketonuria in its homozygous form was given by Dr. V. Cowie (Maudsley Hospital, London). In this disease, first described by Fölling in 1934, about 1 gm. of phenylpyruvic acid is excreted daily in the urine. Dr. Cowie pointed out that mental impairment, usually of a severe degree, is always present, and there are many associated physical features including dilution of hair colour and postural peculiarities. The fundamental defect is a reduced capacity to metabolize phenylalanine through the normal channel by way of tyrosine. Experiments have shown that although this pathway is not completely blocked, phenylalanine accumulates in the blood and cerebrospinal fluid and is eventually excreted after deaminization as phenylpyruvic acid. The way in which the mental and physical abnormalities are produced by the biochemical defect, she said, is not yet clear. However, the condition is present at birth, and attempts at alleviation by dietetic methods have so far been unsuccessful, though the possibilities of very early treatment have not been fully explored.

Besides demonstrating hereditary biochemical specificities within the human species, Garrod directed attention to the biochemical differences between species. An account of a comparative survey of urinary amino-acid patterns in a number of different animal species was given by Dr. S. P. Datta (University College, London). Most of the animals tested were in the London Zoo. Sufficient urine was placed on two-dimensional chromatograms to give up to six main spots. Glycine was almost always present, and alanine and glutamine or glutamic acid occurred very frequently. In the mouse and the binturong, however, only taurine was found. One substance of special interest, a sulphur-containing amino-acid,

purified from cats' urine by Westall, was named 'cat-spot'. In most of the Felidæ it appears to be an alternative to taurine for the excretion of organic sulphur. The Kenya blotched genet has a peculiarity unique among the animals studied in that it excretes very large quantities of cystine. The question as to how so much cystine can be kept in solution in these urines might have some relevance to the study of the prevention of cystine-stone formation in man.

Dr. Datta showed that methyl histidine, which occurs variably in human urine, is always present in laboratory cats which are fed mainly on meat. It is not excreted by animals such as rats, mice, rabbits and guinea pigs, the diets of which are mostly of vegetable origin. By experiments on man, it has been possible to demonstrate that methyl histidine in the urine is probably derived from ingested anserine, a known constituent of muscle. Anserine is hydrolysed in the body to produce beta-alanine, which is further metabolized, and methyl histidine, which is excreted. Thus a peculiarity which superficially resembles an inborn trait turns out on chemical analysis to be mainly a question of diet.

Prof. D. C. Harrison (Queen's University, Belfast) dealt with the rare hereditary disease familial methæmoglobinæmia. He reviewed work done in collaboration with Prof. H. Barcroft, Dr. Q. H. Gibson and others. In methæmoglobinæmia, an abnormally large proportion of the blood pigment hæmoglobin (*Hb*) is changed to the corresponding ferric compound methæmoglobin (*Met-Hb*), which is useless for oxygen transport. In normal blood, the equilibrium $Hb \rightleftharpoons Met\text{-}Hb$ lies far to the left owing to the action of enzyme oxidation-reduction systems in the red blood corpuscles. These systems reduce the methæmoglobin which is constantly being formed from hæmoglobin and prevent the methæmoglobin from accumulating in more than traces. In the type of methæmoglobinæmia caused by certain drugs or (in infants) by nitrates in drinking water, the oxidation of hæmoglobin to methæmoglobin becomes so fast that the restoring enzyme systems are temporarily unable to maintain the normal level of hæmoglobin ; but conditions return to normal when the offending agent is removed. In familial methæmoglobinæmia, on the other hand, the rate of production of methæmoglobin is normal but its rate of reduction is abnormally slow, so that it may accumulate to form as much as 40 per cent or more of the total blood pigment. Denny observed that large doses of ascorbic acid (acting as a reducing agent) shift the equilibrium back towards normal.

The work of Gibson has shown that the disease is due to an enzyme defect in the red blood cells ; there is a shortage of diaphorase I (a flavoprotein enzyme). This shortage was demonstrated by direct assay in the blood of all seven patients who were tested. The values were in every case lower than those of any of the sixteen normal bloods used for comparison. Addition of excess diaphorase I restored full activity. The oxygen dissociation curve of the blood of the patients was found to be shifted to the left, that is, the blood parted with its oxygen less readily than normal. This, coupled with the large amount of pigment present in the abnormal, non-functional state, makes it surprising that the patients as a whole were able to lead active, energetic lives. The compensating polycythæmia which was present in the more severe cases may help to explain this.

The disease is apparently due to a mutation of the gene responsible for synthesis of the flavoprotein diaphorase I. In all three families studied, the disease appeared to be inherited as a recessive Mendelian trait. Prof. Harrison stated that quantitative studies on the blood of relatives of the patients had given no evidence for the presence of detectable genetic carriers. Treatment of the patients (which was successful in all cases) consisted of large daily doses of ascorbic acid continued indefinitely, preferably supplemented by a single dose of methylene blue after the first few days.

GROWING-POINTS IN CYTOLOGY

ON the opening day of the recent British Association meeting in Belfast, a session was devoted by Section D (Zoology) to the discussion of some recent advances in cytology. The first paper, by Mr. I. C. Smith (Dundee), on the curious cytology of Pharaoh's ant, *Monomorium pharaonis* L., followed naturally on Prof. Peacock's presidential address (see *Nature*, September 6, p. 395), which earlier in the day had been concerned with some aspects of hymenopteran reproduction. Pharaoh's ant shares with many other hymenopterans the peculiarity that the males arise from unfertilized eggs by haploid parthenogenesis, or arrhenotoky, with the result that the male germ cells and much of the soma remain haploid. The females, on the other hand, develop from fertilized eggs, so that the female germ cells and much of the soma are diploid. Clearly, the eggs of virgin females can develop only into males.

Since the male germ-line is already haploid, it is obvious that no further reduction can take place in the chromosome number during the maturation of spermatozoa. In the hornet, Meves showed as early as 1904 that, during spermatogenesis, the first meiotic division, which is normally a reduction division, is abortive, while oogenesis is normal. Considerable attention has therefore been paid to the details of the first meiotic division in the spermatogenesis of Pharaoh's ant. Mr. Smith described the untidy nature of this division and the curious fact that about this time a small fragment of cytoplasm separates as a bud. Some have considered this bud to represent a vestigial cell, the remnant of a typical meiotic division ; but there are now good reasons for abandoning this view. The division is, in fact, a normal mitosis, and the two daughter cells develop without any further division into spermatids and spermatozoa, which are, of course, haploid. There is therefore no stage in spermatogenesis which corresponds to a normal first meiotic division.

The meeting then passed on to consider an interesting paper by Dr. R. J. Goldacre (Chester Beatty Institute, London) on the tail region of *Amœba*. Dr. Goldacre began by tilting at the insistence of so many zoologists that the *Amœba* is an animal without form, a point of view that is perpetuated by such names as *Amœba chaos* and *Chaos chaos*. A text-book *Amœba* is said to throw out pseudopodia at random from any part of its surface, whereas the real *Amœba* has an obvious antero-posterior polarity with a well-marked permanent tail, or rear contracting end. This rear end can easily be distinguished as a group of wrinkles caused by a contraction of the cortical gel, which in the tail is liquefying to be squeezed forward up the central channel of the *Amœba*.

That the tail region of an *Amœba* is relatively permanent is shown by the fact that the animal has

never been seen to reverse, even when watched for as long as a week. This fact can also be demonstrated by staining a living *Amœba* with neutral red. The stain becomes concentrated in the tail, which can then be seen to keep its identity for long periods of time. Dr. Goldacre also described how the fate of the tail region can be followed during cell division, and how the tail seems to determine the plane of the division furrow. This furrow is first evident anteriorly, and the tail region is the last part to divide and separate. He therefore suggested that the tail of an *Amœba* may play some important part in the organization of the cell, surviving possibly throughout its whole life by passing from parent to daughter.

The third contribution to the symposium was a paper by Prof. H. G. Callan (St. Andrews); but since he was unable to be present it was read in his absence by Dr. Ann R. Sanderson. A description was given of recent research on amphibian oocyte nuclei, with particular reference to their chromosomes. These nuclei have the attraction that when they have been extracted from the yolky cytoplasm they are large enough to be visible to the naked eye. Investigations have shown that there are at least two, and probably three, materials forming the nuclear sap: a fluid phase extending through a jelly phase, and probably an even more rigid centrally placed jelly in which the chromosomes are embedded. The whole is surrounded by a membrane pierced by close-packed hexagonal pores.

The chromosomes themselves have been the subject of considerable observation, the necessary preliminary being the development of a technique for their extraction. In *Triturus* newts the growing oocytes contain chromosomes in the diplotene of meiosis. These chromosomes are almost 800 μ long and are arranged in pairs joined at one or more points of contact. They are of the type known as 'lampbrush', and it is their peculiarity that loops of material sprout out from the chromosome axis and return to their points of origin. There are many structures along the lengths of lampbrush chromosomes which enable one to map them. In a given position there may be a loop which is short and thin, or long and fuzzy, and there are also well-defined regions concerned with the production of nucleoli. When fully formed, these nucleoli detach themselves and migrate to the nuclear membrane. With all these structures available for matching chromosomes, it is possible to show that the contact points between pairs of chromosomes occur in homologous regions, although they differ in different nuclei. Indeed, they show the same type of variation in position as is shown by chiasmata. The paper ended with the suggestion that the great value of this oocyte material may prove to lie in what it can teach of gene activity, for in examining these lampbrush chromosomes one may really be seeing genes in action.

The session ended with a paper by Prof. W. S. Bullough (Birkbeck College, London) on hormones and cell replacement in the epidermis. The research involved was not strictly cytological, but was rather an example of what can be achieved in biological and biochemical work by the use of cytological methods. It had earlier been shown that the most critical single factor determining the rate of epidermal cell replacement is the rate of energy-production inside the cells. Since it is known that a number of hormones affect the rate of production of energy, a study has now been made of their effect on cell division. Epidermal cells are normally half-starved for glucose, apparently because of their poor powers of absorption of this sugar from the surrounding medium. Insulin is well known to assist the uptake of glucose from the blood by stimulating the hexokinase reaction, and it was found that it also has this effect on epidermis *in vitro* as evidenced by an induced doubling of the rate of mitosis. It is also known that the pituitary growth-hormone inhibits the hexokinase reaction, and experiments have shown that *in vitro* it powerfully inhibits cell-division. This result suggests that a re-examination of the actions of this hormone is now due, and that the substance may prove to have been misnamed. Possibly its ability to promote growth may be through the induced secretion of other hormones such as insulin.

Attention was then turned to the action of the œstrogenic hormones, which also stimulate epidermal cell-division both *in vivo* and *in vitro*, and evidence was briefly reviewed which indicates that they too act by facilitating the hexokinase reaction. However, *in vivo* the stimulus they exert is only short-lived, and a reaction quickly sets in. This appears to be due, at least in part, to some stimulus to the adrenal cortex, which then actively secretes hormones similar to cortisone. Both *in vivo* and *in vitro* cortisone depresses the rate of production of energy and of epidermal mitosis. Androgens do not induce over-activity of the adrenal cortex with growth inhibition, and this fact suggests a reason for the larger body-size of so many male mammals.

The session ended with a lively discussion, ranging in subject from protozoans to cancer.

APPLICATION OF RADIOACTIVITY TO MINERAL DRESSING

THE third Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy was given on September 22 at the Royal Institution before a gathering of mineral-dressing engineers who had come to London from many parts of the world to attend the first symposium on this subject to be held in Great Britain. The lecturer, Prof. A. M. Gaudin, Richards professor of mineral engineering in the Massachusetts Institute of Technology, chose for his subject "The Application of Radioactivity to Mineral Dressing".

Radioactivity can be used in three ways—as a research tool, for the control of plant processes, and in the direct separation of radioactive from inert minerals. Beta- and gamma-radiation is employed, the limitations of the alpha-rays making them unsuitable. Such properties as self-diffusion, adsorption across the liquid/solid interphase of minerals suspended in fluids, rates and site packings, as well as the mode of movement are of critical research importance in the exploration of surface phenomena used in the process of froth flotation. Prof. Gaudin's lecture not only showed some of the work which is being done but also gave fascinating glimpses of possible new methods of mineral-dressing research. In the complex field of attrition, the use of labelled particles of a closely defined size-range as part of the total mixture of wide-ranging sizes fed into an attrition mill is throwing light on the selective grinding which goes on among these sizes under controlled conditions. Natural radioactivity is in use in north-west Canada to actuate sorting mechanisms which segregate the uranium-bearing ore from inert

material, and the same process is being studied for possible use with artificially induced, short-lived radioactivity (gamma-radiation) for a selected mineral such as one containing beryllium.

Another incipient aid to fundamental work promises to be the differentiation between slightly varying crystals of what are loosely grouped as the same mineral. For example, galena (lead sulphide) could be thought of as being just galena; but minute traces of impurity and minute variations in its lattice structure and discontinuity make profound differences in its behaviour, both in study and in its practical concentration from its ores. These differences can be greatly magnified by the use of suitable radioactivating techniques.

The Lecture provided an admirable introduction to the symposium held at the Imperial College of Science and Technology, London, by the Institution of Mining and Metallurgy during the following three days, when about forty papers were presented and at which a wide variety of research and practical aspects of this important and growing technology was examined. In recognition of his distinguished services, honorary membership of the Institution of Mining and Metallurgy was conferred on Prof. Gaudin before he gave the Lecture.

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1951

THE thirty-second annual report of the Research Council of Alberta*, describing the work of the Council in 1951, again stresses the work on the bituminous oil sands; and preparation for the Athabasca Oil Sands Conference, which was sponsored by the board of trustees of the Oil Sands Project, made heavy demands on the Research Council's staff. The terms 'bituminous sand' and 'tar sand' have now been dropped, because of their false implication, in favour of 'oil sands'. Laboratory investigations have confirmed the presence of vanadium in the oil sand, both as a mineral and as a component of the oil, especially in the resin and asphaltene fractions. Some work was done on the characteristics of the flow of sand suspensions, including a study of the friction factor in pipes, as well as on the electrical resistance of oil sand and its breakdown under a high potential difference.

A balanced programme of studies on coal included a study of the absorption spectra of oxidation degradation products of Alberta sub-bituminous coals in aqueous solution, of the cleaning of coal with cyclone washer equipment, analytical and physical testing, and of the physical properties of magnetite, Burmis iron ore, loess, limestone and tailings from a zinc refinery with reference to their suitability for the preparation of the media used in dense-media processes of cleaning coal.

A reconnaissance pleistocene survey was made of the Lake St. Ann map area, and the Gasoline and Oil Testing Laboratory again surveyed gasolines sold in the area and initiated a study of viscosity data at low temperatures on aviation lubricating oils diluted with aviation fuel, and one on the effect of storage time on preformed gum, and on 5-hr. and 16-hr. potential gum tests on aviation fuel. The pyrolysis of natural gas, the partial oxidation of butane, and the National Research Council's Pidgeon process for carbon black received attention, while irrigation soil-survey work on the Bow River project was started and the William Pearce project was continued. A re-survey of the Edmonton map sheet was commenced, and work on the Sturgeon Lake sheet resumed. The investigation of biological cycles continued, particularly with reference to the fluctuations of wild life in northern latitudes, and measurement of ultra-violet solar radiation continued with the thorium photo-cell and with a zirconium photo-cell in spite of adverse conditions. A list of publications of the Council is appended.

* Thirty-second Annual Report of the Research Council of Alberta, 1951. Pp. 32. (Edmonton: Queen's Printer, 1952.)

A WAVE-RECORDER FOR USE IN SHIPS

By M. J. TUCKER

National Institute of Oceanography

ALTHOUGH sea-waves have been recorded for a number of years using shore-connected pressure-measuring instruments or inverted echo-sounders laid on the sea-bed, collection of exact information about waves, studies of the growth of waves relative to the wind, and studies of ship motion and of coastal changes relative to the waves have always been retarded by the absence of a reliable method of continuously recording waves from a ship in deep water.

Some measurements have been made by a method in which an observer stations himself at such a height that the top of a wave comes just level with the horizon when the ship is on a fairly even keel in the trough. Much more accurate measurements have been made by stereo-photogrammetric methods using cameras with a long base-length mounted high on the ship.

Neither of these methods is satisfactory for obtaining a continuous picture of changing wave conditions, and for this purpose the best method until recently has been that employed before the Second World War by the Deutsche Versuchanstalt für Luftfahrt for the study of seaplane landings in a variety of wave conditions. In this method a pressure recorder was suspended on a steel wire 100–200 ft. below a flat lens-shaped float: because of the rapid attenuation of wave-pressure with depth, the recorded pressure fluctuations were mainly due to the recorder following the vertical movements of the float on the surface. A correction could be made for the residual wave motion at the depth of the recorder when the presence of long waves made this necessary. The pressure fluctuations were recorded by a diaphragm connected to a diamond which scratched a spiral record on a polished steel cylinder rotated and moved along its axis by clockwork. The scratch recorder has been replaced in Great Britain by an electrical pressure recorder the output of which is transmitted to the attendant ship by wireless or by a buoyant cable, but the basic idea is the same. Measurements have also been made by an apparatus attributed to Froude and which consists of a buoyant graduated pole held vertical by a weight on its lower end and kept steady in the water by a drogue of relatively large area suspended on 200 ft. of wire from the bottom of the pole. The movements of the water up and down the pole are usually observed visually or photographed, but on a recent voyage of the R.R.S.

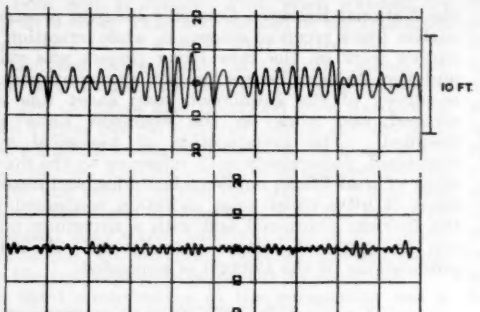

Fig. 1

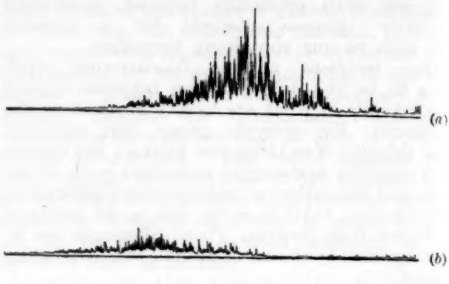

Fig. 2

Portions of records taken with the wave-recorder (Fig. 1) and the corresponding frequency spectra (Fig. 2): (*a*) accelerometers only connected; (*b*) pressure measurements only; (*c*) combined output giving true wave record. The records were taken in sequence, so that the wave record is not the sum of the other two records in detail. It can be seen, however, that the spectrum of the wave record is the approximate sum of the other two

Discovery II satisfactory measurements were obtained by attaching a limp air-filled rubber bag to a point below the mean water-level on the pole and communicating the changes in pressure to the ship through hose-pipe.

All these methods involve laying out apparatus from the ship and recovering it, and, if the apparatus is connected to the ship by a cable or hose-pipe, it is also necessary to hold the ship stationary to prevent the apparatus being towed through the water. These operations can be difficult, particularly in bad weather, when the results may be of greatest interest, and suitable stowage of the comparatively delicate and bulky equipment may not be easy. The advantages of a recorder contained entirely inboard are apparent.

The officers of the German research vessel *Gazelle* (1874–76) used a very sensitive aneroid barometer to measure the fluctuations in air pressure caused by the waves and the movements of the ship, but the uncertainties of this method are too great to enable it to be relied upon.

The new instrument developed by the National Institute of Oceanography is contained completely within the hull of the ship and is well suited for routine measurements. In principle it measures the height of the water surface above some point on the ship's hull and the height of this point above an imaginary reference plane. The sum of the two measurements gives the height of the water surface above the reference plane, and hence is independent of the movement of the ship. The height of the water surface above the point on the ship's hull is measured by the pressure transmitted through a small hole in the ship's side, and the displacement of the point is measured by means of a vertical accelerometer the output of which is integrated twice electronically with respect to time. To allow for the effects of reflexion of short waves from the sides of the ship, a pressure-recorder – accelerometer unit is fitted in each side of the ship, and the mean of their outputs is taken. The response of this arrangement to waves which are only partially reflected has not been rigorously calculated; but it is apparent from physical reasoning that large errors will not be introduced.

The units have to be mounted some distance below the water-line because the point of pressure-measurement must always remain below the water surface, and they will therefore not measure very short waves. If the units are 10 ft. below the water-line, the response will drop to approximately half for waves of 4 seconds period.

To measure true vertical accelerations the accelerometers should be mounted on gyroscopes or long-period compound pendulums; but, to simplify design and to reduce both the space and maintenance required, they are in practice mounted on short-period pendulums which set themselves into the apparent vertical. This results in an apparent increase in gravity (that is, an increase in the mean output of the accelerometers) when the ship moves into a wave train, because the water particle motion, and hence the ship motion in the longer waves, is in circular orbits. If this increase were truly integrated the output would drift off scale; but, by a correct choice of the time constants of the integrating circuits and by including a resistance-capacitance coupling in the circuit, the effect can be minimized and does not appear to be serious in the present instrument.

To avoid trouble from instrumental drift, the accelerometers must be very linear and give large voltage outputs. The accelerometers in this instrument have a sensitivity of approximately 30 volts/g and are linear within about 1 per cent over the range $-0{\cdot}4$ to $+0{\cdot}4\,g$.

The first of these wave-recorders, fitted in the R.R.S. *Discovery II*, the research ship of the National Institute of Oceanography, has been tested during a recent cruise in the North Atlantic Ocean. During this cruise, which lasted 2½ weeks, a gale of force 9

was encountered and waves with a maximum height of approximately 30 ft. were measured. The instrument behaved satisfactorily during this period and developed no faults. Records from the instrument were compared with those obtained from pressure and echo-sounding wave-recorders in shallow water, and with records from the electric and pole and drogue recorders as already outlined. Preliminary analyses of these results show satisfactory agreement. The overall accuracy of the instrument in its present form is estimated at ± 10 per cent.

Portions of three records are shown in Fig. 1 with the corresponding analyses in Fig. 2. (*a*) is the output of the instrument with only the accelerometers connected, (*b*) the output with only the pressure units connected, and (*c*) the combined output. The records are not simultaneous, but were taken in sequence. They demonstrate that the pressure units measure the short waves to which the ship does not respond, whereas the accelerometers measure the waves which are long enough to cause the ship to heave.

In conclusion, I would like to acknowledge the help of Mr. F. E. Pierce, who was mainly responsible for the mechanical design of the instrument.

NEW AMINO-ACIDS IN YOUNG APPLE FRUITS

By Dr. A. C. HULME and W. ARTHINGTON

Ditton Laboratory (Department of Scientific and Industrial Research), East Malling, Kent

A PRELIMINARY examination of the amino-acids present in young (10 gm.) fruits of Bramley's Seedling apples by means of filter-paper chromatography[1] suggested the presence of at least one 'unknown' amino-acid. A more extended examination of young (15 gm.) Worcester Pearmain apples indicated the presence, on two-dimensional chromatograms, of at least four spots reacting to ninhydrin in positions not attributable to any recorded amino-acid[2]. The position of these four substances (*A*, *B*, *C* and *D*) will be seen from Fig. 1, which represents a two-dimensional chromatogram of the amino-acid fraction absorbed from extracts of these young apples on 'Zeokarb 215' and displaced by 0·15 *N* ammonia, and from which a considerable portion of the asparagine (which comprises about 80 per cent of the total soluble nitrogen of the fruit) had been removed by crystallization.

In more recent work substance *A* has not appeared, and substance *C* has been found to be a peptide. To isolate, for identification, substances *B* and *D*, which were clearly present in the fruits in very small quantities, extracts were made of 70 kgm. of pulp tissue from Worcester Pearmain apples (15 gm.) and the extracts suitably treated for the separation of the amino-acid fraction. By fractionation of the mixed amino-acids on a range of ion-exchange resins, a simple mixture was finally obtained which comprised practically all substance *D*, some γ-amino butyric acid, β-alanine, and a little proline and substance *B*. At this stage a peculiarity of substance *D* became very obvious. In early two-dimensional chromatograms the spot attributed to *D* sometimes gave a yellow colour with ninhydrin, sometimes a purple colour and sometimes a mixture of the two. When the purple colour was present, the ninhydrin-treated spot fluoresced a bright magenta colour in ultra-violet light. Since the two colours were never separated on conventional two-dimensional chromatograms and on single-dimensional chromatograms in butanol – acetic acid – water, it was at first thought that the 'two-colour' appearance was either analogous to the 'two-colour' spot often given by a compound such as methyl histidine or due to a peculiar structure of the compound. On careful fractionation of the simple mixture already mentioned on a lightly cross-linked polystyrene resin[3], fractions were obtained which on chromatograms gave a sequence of spots as shown in Fig. 2. Early fractions, associated with proline, gave a yellow colour with ninhydrin, middle fractions a mixed colour spot, and later fractions a purple spot (and no other ninhydrin-reacting substance) which fluoresced a bright magenta colour in ultra-violet light. In the final fractions γ-amino butyric acid, β-alanine, etc., also appeared. Thus it became virtually certain that 'substance' *D* was in fact two substances: *D*1, the acid reacting yellow with ninhydrin, and *D*2, the acid giving a purple colour with ninhydrin and fluorescing a magenta colour in ultra-violet light. By a further fractionation on a small column of the sulphonated polystyrene resin, a few milligrams each of two sets of crystals

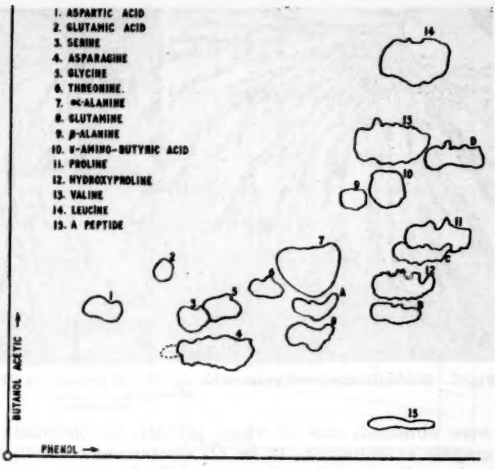

Fig. 1. Chromatogram prepared from an extract of young Worcester Pearmain apples

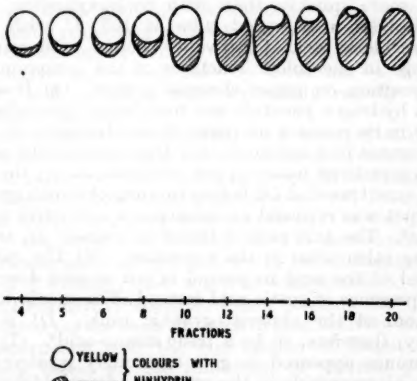

Fig. 2. Chromatogram of fractions containing amino-acids *D*1 and *D*2

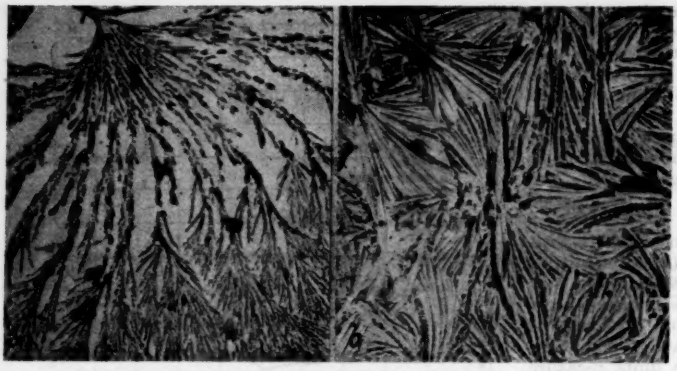

Fig. 3. Photomicrographs of amino-acids (× 35): (*a*) preparation *D*1 and proline; (*b*) preparation *D*2

were obtained, one of which proved, on chromatographic examination, to be *D*1 contaminated with a little proline and the other pure *D*2 (about 60 mgm.). The known properties of these acids are as follow.

*Properties of D*1. (1) The acid gives a lemon-yellow colour with ninhydrin. (2) On filter paper it gives a pure blue colour on spraying with 0·1 per cent isatin in ethanol – butanol (1 : 1 v/v) and heating the paper to 110° C. for 1–2 minutes. This isatin test was first applied in filter-paper chromatography by Acher, Fromageot and Jutisz[4]. Of many known amino-acids tried, the blue colour is given only by the pyrrolidine derivatives proline and hydroxyproline, and it is surprising that this extremely useful test has not been more widely used. As described by Acher *et al.*, proline gives a blue very rapidly and hydroxyproline a somewhat fainter colour which develops rather more slowly during heating. We have found that tryptophane gives a bright rose-red colour. Other amino-acids tried (citrulline, asparagine, tyrosine, dihydroxyphenylalanine, leucine, α- and β-alanine, N-hydroxyl ethyl β-alanine, histidine hydrochloride, γ-amino butyric acid, taurine, and sarcosine hydrochloride arginine) give pink to purple colours after more prolonged heating of the isatin-sprayed paper, but the intensities of the colours are much less than those given by the pyrrolidines and tryptophane. Pyrrole does not give the blue colour. The blue isatin colour given by compound *D*1 appeared on heating almost as quickly as that given by proline and more quickly than with hydroxyproline. (3) Hydrolysis in a sealed tube at 103° C. with 6 *N* hydrochloric acid for twenty hours produced no change in the colour reactions of the compound or its position on paper chromatograms. (4) Heating with hydrogen peroxide and molybdate[5] produced no shift in its position on paper chromatograms, so that *D*1 cannot be a sulphone. (5) After dusting the paper with powdered basic copper carbonate along the line of future travel of *D*1 before running chromatograms, no spot was revealed on subsequent ninhydrin treatment[6]. The acid cannot therefore contain an amino group other than in the α-position. (6) The rate of travel of the acid in phenol is not slowed down by the presence of acetic acid instead of ammonia in the bottom of the chromatographic tank; *D*1 is not likely, therefore, to be a basic amino-acid[8]. (7) The substance appeared to give a strongly positive test with nitroprusside in the presence of acetaldehyde—a test for a secondary amine[7]—but since it has so far been impossible to obtain the compound completely free of proline, this test is not conclusive.

*Properties of D*2. (1) It gives a blue colour with ninhydrin when run on paper, the colour changing to purple as the paper cools. The ninhydrin-treated spot fluoresces a strong magenta colour in ultraviolet light. (2) With isatin the substance gives a bright greenish-blue colour which develops immediately on heating the isatin-sprayed chromatogram. (3) The acid is unaffected by heating with 6 *N* hydrochloric acid in a sealed tube for twenty-four hours. (4) It disappears from chromatograms treated with basic copper carbonate and cannot therefore contain an amino group in other than the α-position. (5) It gives a positive test for a secondary amine[7].

As can be seen from the photomicrographs in Fig. 3, acid *D*2 crystallizes in the form of long, flat, rather feathery needles. Acid *D*1 has a somewhat similar form, but the crystals shown are from a sample contaminated with proline.

The R_F values of both *D*1 and *D*2 are shown in the table. From its reactions, including the close company it keeps with proline on ion-exchange resins and the fact that it has a higher R_F value in butanol–acetic acid – water than proline, it appears that *D*1 might well be an alkyl proline, probably methyl proline.

R_F Values (at 20° C.) of Various Amino-acids in Various Solvents

Solvent*	R_F value			
	OH-proline	Proline	*D*1	*D*2
Butanol–acetic acid–water (4 : 1 : 5 v/v)	0·19	0·30	0·44	0·42
*iso*Butyric acid–water (40 : 60 v/v)	0·41	0·60	0·71	0·67
Phenol–ammonia	0·65	0·92	0·88	0·92

* Paper equilibrated for 24 hr. with solvent-poor phase before solvent run commenced.

The elementary analysis of *D*2 was found to be: C, 55·4 per cent; H, 8·75 per cent; and N, 10·8 per cent. This corresponds with the formula $C_6H_{11}O_2N$. Methyl proline and the piperidine carboxylic acids have this molecular formula. Synthetic piperidine 2-carboxylic acid was prepared[9] and found to have all the properties of *D*2. Mixed melting points and a comparison of the chromatographic behaviour of the two compounds has established that *D*2 is, in fact, piperidine 2-carboxylic acid. (It has just been noted that this acid has now been isolated from beans[9].)

Apart from the interest aroused by the presence of this acid in fruits, it is surprising to find an imino-acid giving a bright purple colour with ninhydrin.

The work here described was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. [July 10.

[1] Hulme, A. C., and Arthington, W., *Nature*, **165**, 716 (1950).
[2] Hulme, A. C., and Arthington, W., unpublished results. Ditton Laboratory Interim Record No. 9 (1950).
[3] Partridge, S. M., Brimley, R. C., and Pepper, K. W., *Biochem. J.*, **46**, 334 (1950).
[4] Acher, A., Fromageot, C., and Jutisz, M., *Biochim. Biophys. Acta*, **5**, 81 (1950).
[5] Dent, C. E., *Biochem. J.*, **43**, 169 (1948).
[6] Dent, C. E., and Crumpler, H. R., *Nature*, **164**, 441 (1949).
[7] Feigl, F., "Quantitative Analysis by Spot Tests", 371 (New York: Elsevier, 1947).
[8] Stevens, C. M., and Ellman, P. B., *J. Biol. Chem.*, **182**, 75 (1950).
[9] Zacharius, R. M., Thompson, J. F., and Steward, F. C., *J. Amer. Chem. Soc.*, **74**, 2949 (1952).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Extension of the *K*-Region Hypothesis of Carcinogenic Chemical Compounds

WORKING on suggestions put forward by Schmidt and by Swartholm, a number of French and English workers, notably A. Pullman, B. Pullman, P. Daudel, R. Daudel and C. A. Coulson, have developed a hypothesis relating the carcinogenic power of polycyclic aromatics to the structures of these compounds on the basis of quantum mechanics. Evidence has been accumulating in recent years which does indicate a fair correlation to exist between the reactivity calculated for the most reactive double bond in these molecules and their carcinogenicity. The reactive region thus supposed to be mainly responsible for neoplastic activity is usually termed the *K*-region.

Whereas the various theoretical methods used in assessing the above double-bond reactivity appeared to give fairly consistent results, some rather striking deviations were found as regards biological activity[1].

Several attempts have been made to determine double-bond reactivity by experimental means. However, both the perbenzoic acid addition method employed by Eckhardt[2] and by Boyland[3], and the osmium tetroxide addition method developed by Badger[4]—although in fair agreement with the available quantum mechanical results—again revealed several discrepancies with regard to carcinogenicity.

Being engaged in investigating the interaction of trichloromethyl radicals with various types of hydrocarbons[5], we worked out a method for the determination of the relative reactivities of these radicals towards unsubstituted polycyclic aromatics at 90° C. As recently reported[6], the rates of addition (K_R) were found to parallel the highest free valence numbers calculated for these compounds by means of the molecular orbital method. Therefore, the order of reactivities will probably be quite similar when radicals other than CCl_3 are involved, or when slightly lower temperatures are used.

RELATIVE REACTIVITIES OF POLYCYCLIC AROMATICS TOWARDS OSMIUM TETROXIDE (K_{OsO_4}) AND TOWARDS CCl_3 (K_R)*

Compound	K_{OsO_4}	K_R	Remarks (cf. graph)
3,4-Benzopyrene	0·94	2·85	
20-Methylcholanthrene	1·1	1·95	
Cholanthrene	1·0	1·8	
Benzanthracene	0·48	1·25	
1,2-Dimethylchrysene	0·84	0·5	
2′,7-Dimethylbenzanthracene	0·82	0·21	
9,10-Dimethylbenzanthracene	2·7	0·21	
1,2,5,6-Dibenzanthracene	0·64	0·16	
Naphthacene	—†	4·4	Represented by points parallel to the K_R axis
9-Cyanoanthracene	—†	1·3	
Anthracene	—†	0·9	
Pyrene	—†	0·04	
Phenanthrene	(0·05)†	0·01	
9-Methylbenzanthracene	0·96	—‡	Represented by points parallel to the K_{OsO_4} axis
10-Methylbenzanthracene	0·91	—‡	
5,6-Dimethylbenzanthracene	0·64	—	
9,10-Diethylbenzanthracene	2·1	—§	
9-Methyl-10-cyanobenzanthracene	0·40	—	
5,6,9,10-Tetramethylbenzanthracene	2·9	—	
Acenaphthanthracene	1·1	—	

* K_{OsO_4} was determined at 37° C., K_R at 90° C.

† Not determined; judging from the low bond orders found for the most reactive 'double bonds' in these compounds, these values will be very low. Phenanthrene was found by Badger and Reed (*Nature*, 161, 238; 1948) to be about ten times less reactive towards osmium tetroxide than benzanthracene.

‡ Probably greater than 1·2 as the presence of the mesomethyl group may increase the free valence number of the opposite meso-position.

§ Probably below 0·25 (cf. 9,10-dimethylbenzanthracene).

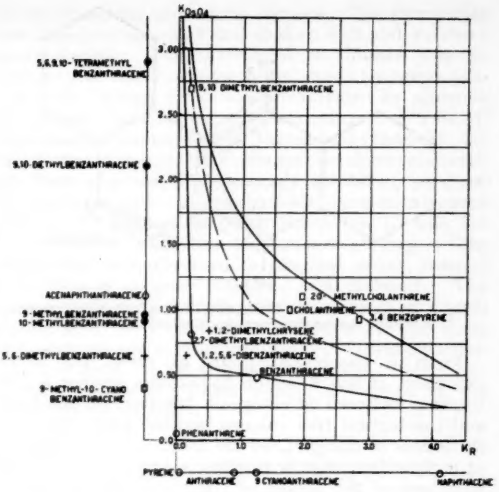

Fig. 1. □—□—, Highly active carcinogen; ●—●—, active carcinogen; +—+—, moderate activity; ○—○—, little or zero activity. (Gradings according to ref. 3)

In the course of the latter investigation, we also determined the K_R values of a number of substituted aromatics at our disposal. The results are given in the accompanying table, together with the osmium tetroxide addition-rates reported by Badger[4].

In view of the fact that several biological processes are now believed to involve homolytic rather than heterolytic reactions[7], we thought it of interest to plot K_{OsO_4} against K_R (Fig. 1).

The admittedly limited number of data would seem to suggest that carcinogenic potency depends on a quantitative relation between the two different reactivities, rather than on the *K*-region—as measured by K_{OsO_4}—alone. This supposed relationship has been illustrated in the graph by hyperbolic curves. Thus, the compounds within the region between the lower curve and the co-ordinate axes have zero or low activities, whereas the two upper curves should include a region of comparably high activity. The present data give no indications as to whether decreasing neoplastic activity will occur in the region beyond the upper curve. (However, styrene, which is inactive and which has—by definition—a K_R of 0·50[6], will probably react extremely rapidly with osmium tetroxide.)

Unfortunately, compounds which are very striking exceptions to the relation between carcinogenic power and *K*-region activity, such as acenaphthanthracene and 9-methyl-10-cyanobenzanthracene (cf. footnotes in the table), were not available to us. On the other hand, the very low activity of 2′,7-dimethylbenzanthracene and the high potency of the cholanthrenes and of 3,4-benzpyrene, which is comparable to that of 9,10-dimethylbenzanthracene, cannot be well correlated on the basis of the *K*-region activity alone. In accordance with the conclusions of Magat and Bonême based on the inhibition of thermal polymerizations of styrene by carcinogens[8], there appears to be no direct relation between neoplastic activity and reactivity towards radicals.

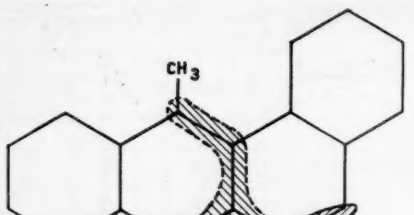

Fig. 2. Supposed reactive region in 9,10-dimethylbenzanthracene, including the reactive meso-positions and the *K*-region

From a theoretical point of view, the above extension of the *K*-region hypothesis implies a relationship between carcinogenic potency, on one hand, and the highest free valence number and bond order (or excess of charge[1]), on the other. As the positions of highest free valence number scarcely ever coincide with one of the atoms of the most reactive double bond[1], this suggests that a larger part of the molecule is involved in the carcinogenic mechanism than the *K*-region alone (Fig. 2). (According to the molecular orbital method, the free valence number of a given atom is obtained by subtracting the sum of the bond orders of the bonds terminating at that atom from a constant which is characteristic for that atomic species and its binding type[9].)

It may be remarked that such a possibility was recently mentioned by Boyland[1]; his interesting hypothesis, however, deals with structural properties of carcinogens rather than with different types of reactivity.

The requirement of two different types of reactivity within a single molecule suggests possibilities for interpretation or experimental attack as regards combination or inhibition effects; for example, by studying the biological effect of a potent carcinogen admixed with a non-carcinogenic compound having a high K_{OsO_4}. Strong evidence for the existence of these effects has been given by Lacassagne *et al.*[10].

In conclusion, it is emphasized that the above speculation ensued as a sideline from fundamental work on hydrocarbons in progress in this laboratory. Thus we have not attempted any detailed verification; our main intention is to direct attention to a number of data which may suggest that free radical reactions play a part in a field of such widespread interest as carcinogenesis.

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[1] Boyland, E., *J. Chim. Phys.*, **47**, 942 (1950). Cf. Truhaut, R., in "Les facteurs chimiques de cancérisation" (Sedes, Paris, 1948), and Prato, M., and Nebbia, G., in "Le sostanze cancerigene" ("Leonardo da Vinci" ed., Bari, Italy, 1950).
[2] Eckhardt, H. J., *Ber.*, **73**, 13 (1940).
[3] Boyland, E., *Biochim. et Biophys. Acta*, **4**, 293 (1950).
[4] Badger, G. M., *J. Chem. Soc.*, 456 and 1909 (1949). Badger, G. M., and Lynn, K. R., *ibid.*, 1726 (1950).
[5] For example, Kooyman, E. C., *Dis. Farad. Soc.*, **10**, 163 (1951).
[6] Kooyman, E. C., and Farenhorst, E., *Nature*, **165**, 153 (1952).
[7] Cf. Waters, W. A., "The Chemistry of Free Radicals", chap. 12 (Clarendon Press, Oxford, 1948).
[8] Magat, M., and Bonême, R., *C.R. Acad. Sci., Paris*, **232**, 1657 (1951).
[9] Cf. Burkitt, F. H., Coulson, C. A., and Longuet-Higgins, H. C., *Trans. Farad. Soc.*, **47**, 553 (1951).
[10] Lacassagne, A., Buu Hoï, Ng., and Rudali, G., *Brit. J. Exp. Path.*, **26**, 5 (1945).

Carbohydrate Residue of a Urine Mucoprotein inhibiting Influenza Virus Hæmagglutination

The first step in the propagation of influenza virus is the adsorption of the infective particle on to the receptor substance at the surface of the host cell. Human, guinea pig and fowl erythrocytes, though not susceptible to infection, possess analogous receptors which, by allowing virus particles to form 'bridges' between cells, give rise to the hæmagglutination characteristic of influenza viruses[1]. A variety of soluble mucoids, by competing with the cellular receptors for the virus, inhibit hæmagglutination[2]. There is much indirect evidence to suggest that the receptors and the soluble mucoids have some basic structure in common, that this common structural feature is predominantly of carbohydrate nature and that the carbohydrate is instrumental in the attachment of the virus to the cell receptors and their mucoid analogues[3]. In fact, the inactivation by living virus of the capacity of a mucoprotein to inhibit hæmagglutination by indicator virus is accompanied by the release of a sugar derivative characterized as an N-substituted fructosamine[3].

The availability of a pure mucoprotein from urine[4] inhibiting the virus hæmagglutinin to a high titre rendered possible an investigation of its carbohydrate residue. With this mucoprotein prepared by a modified technique[5], three series of experiments were performed:

(1) *Acid hydrolysis:* (*a*) *Simple sugars.* The hydrolysate from acid treatment (1 *N* sulphuric acid, 100°, 4½ hr.), after removal of the acid as barium salt, was dialysed at 4° against 10 volumes of water. The concentrated dialysate was analysed qualitatively and semi-quantitatively[6] by paper-partition chromatography (descending), using butanol/acetic acid/water (40 : 10 : 50) and *s*-collidine as solvents and aniline hydrogen phthalate as spraying agent. The results were as follows: 5·4 per cent galactose, 2·7 per cent mannose, 1·0 per cent fucose. The fucose content of the untreated mucoprotein, estimated spectroscopically by courtesy of Prof. Z. Dische, of New York, was found to be 1·1 per cent. Xylose present in traces (about 0·04 per cent) may be regarded as an artefact. (*b*) *Amino sugars.* The hydrolysate (2 *N* hydrochloric acid, 100°, 14 hr.) contained 7·6 per cent hexosamine (base), as determined colorimetrically[7]. From chromatographic evidence it would appear that the hexosamine is a mixture of glucosamine and galactosamine (run in *s*-collidine at 4°, sprayed with Ehrlich reagents). This identification is based on: (i) the identity in R_F value and colour of the two assay spots with the spots given by the glucosamine and galactosamine standard respectively; (ii) the positive ninhydrin reaction of the two assay spots; and (iii) the observation that addition of a glucosamine–galactosamine mixture to the hydrolysate resulted in an intensification of the pre-existing spots but not in the appearance of further ones.

(2) *Periodate oxidation.* When the mucoprotein was treated with an excess periodate (0·01 *M* potassium periodate, *p*H 5·0, 20°, 24 hr.), followed by acid hydrolysis, neutralization and dialysis as under (1), half the galactose and mannose, a fraction only of hexosamine and none of the fucose were recovered.

(3) *Alkaline treatment.* By treatment of the mucoprotein with 10 per cent barium hydroxide at 100° for 12 hr., the carbohydrate complex may be separated

from the bulk of the protein. After removal of the insoluble residue and concentration of the supernatant, the polysaccharide was precipitated by 66 per cent ethanol; on acid hydrolysis it yielded galactose, mannose, fucose and hexosamine. This hydrolysis was accompanied by the formation of considerable amounts of soluble and insoluble humin matter, suggesting the presence in the polysaccharide of the component released from the mucoprotein by viral enzyme action[3]. The polysaccharide is dialysable through 'Cellophane' casing.

From these observations, it may be concluded that the smallest carbohydrate unit in the mucoprotein consists of approximately six hexosamine, four galactose, two mannose, one fucose residue(s) and probably of another minor component corresponding to the molecular weight of about 2,500 (assuming N-acetylation of the hexosamine residues) or a multiple n thereof, if the smallest unit contains more than one fucose residue. However, the dialysability of the polysaccharide obtained from the mucoprotein by alkali treatment or, in preliminary experiments, by tryptic digestion, would suggest that n is not more than 3 or 4; crystalline lysozyme (mol. weight 16,000) in a buffer solution of pH 6·0 passes through the membrane to a minute degree only. Therefore the smallest unit $(2{,}500)_n$ may be regarded as a complete prosthetic group rather than the repeating unit of a giant polysaccharide. The mucoprotein, then, is visualized as a conjugated protein containing as prosthetic group a relatively small polysaccharide; about two hundred of such groups may be linked to each protein molecule (on the basis of 7×10^6 mol. weight[4]). This concept is consistent with the biological[5] and biochemical[1] data. It seems of considerable interest that the carbohydrate moiety of the receptor substance present at the surface of human erythrocytes consists of glucosamine, galactosamine, galactose and fucose[6], though only further work with periodic acid will reveal any common structural features of the identical components of the cellular receptors and their soluble analogues.

Prof. G. Blix, University of Uppsala, kindly informed me that his laboratory is also engaged in an analysis of the carbohydrate residue of the urine inhibitor, and we agreed to submit to *Nature* simultaneously but independently a summary of our results.

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[1] Hirst, G. K., *J. Exp. Med.*, **76**, 195 (1942); **78**, 99 (1943).
[2] Burnet, F. M., Croonian Lecture, *Proc. Roy. Soc.*, B, **138**, 47 (1951).
[3] Gottschalk, A., *Nature*, **167**, 845 (1951).
[4] Tamm, I., and Horsfall, F. L., *Proc. Soc. Exp. Biol. and Med.*, **74**, 108 (1950); *J. Exp. Med.*, **95**, 71 (1952).
[5] Ada, G., and Gottschalk, A., *Aust. J. Science*, **14**, 160 (1952).
[6] Gottschalk, A., *Biochem. J.* (in the press).
[7] Elson, L. A., and Morgan, W. T. J., *Biochem. J.*, **27**, 1824 (1933).
[8] Burnet, F. M., *Aust. J. Exp. Biol. Med. Sci.* (In the press).
[9] McCrea, J., *Fed. Proc.*, **11**, Pt. 1, 476 (1952).

IN a study carried out in this Institute on the polysaccharides of normal human urine, particular attention was paid to the urinary mucoprotein reported to inhibit influenza virus hæmagglutination[1].

The inhibitory substances to be reported here were prepared in three different ways. (1) A preparation was made by the method of Tamm and Horsfall[1], by precipitating urine with ethanol. The precipitate was dissolved in water and shaken with chloroform–amyl alcohol. The interfacial precipitate was redissolved in water, dialysed, and dried by lyophilization. (2) Diluted urine was precipitated by addition of sodium chloride to a concentration of 0·58 M, according to the method of Tamm and Horsfall[2]. By this means, these authors obtained an electrophoretically homogeneous, very strongly inhibiting product. No details about its carbohydrate components were given. (3) Urine was centrifuged for 15 min. at 45,000 r./min. in a Sharples supercentrifuge. The precipitate was dissolved in distilled water, washed with 0·58 M sodium chloride, and dialysed. The solution was then centrifuged for one hour at 22,000 r./min. and the supernatant lyophilized. All three preparations are strong inhibitors of hæmagglutination and show about the same activity.

Some of the analytical results are given in the accompanying table.

Component	Amount in preparation (per cent)		
	1	2	3
Hexosamine	6·4	9·4	7·0
'Sialic acid'	8·2* 7·3†	9·2* 9·1†	9·4* 9·1†
Hexose	6·8	8·4	9·0
Fucose	0·7	1·1	1·1
Nitrogen	11·2	10·9	10·7
Phosphorus	—	0·09	0·16
Sulphate sulphur	—	0·4	0·8

* 'Direct' Ehrlich reaction (ref. 3). † Bial's reaction (ref. 3).

In addition to the quantitative determinations given in the table, the following analysis was carried out. Preparation 2 was hydrolysed and studied by paper-partition chromatography. Spraying with aniline phthalate indicated the presence of galactose, mannose, and a small amount of fucose. With ammoniacal silver nitrate as spraying reagent, the presence of hexosamine was also indicated.

The analytical results indicate that the inhibitory mucoprotein contains, in addition to 'sialic acid', carbohydrate of the glucosamine–mannose–galactose type commonly occurring in proteins, and a small amount of carbohydrate of the type occurring in blood-group substances.

The name 'sialic acid' has recently[4] been given to a monobasic reducing acid with the probable composition $C_{14}H_{24}NO_{11}$, which was first isolated in crystalline form from submaxillary mucin in 1936[5]. Its structure is still unknown. It is characterized by strong humin formation and liberation of carbon dioxide on heating with mineral acid. It gives a purple colour even without previous treatment with alkali on heating with Ehrlich's p-dimethylaminobenzaldehyde reagent, and a violet colour when treated with Bial's orcinol reagent. Judging from these reactions, sialic acid or closely related substances are widely distributed in the animal organism[3]. Sialic acid seems to be regularly accompanied by chondrosamine[4].

From observations made in a study of the dialysable product split off by the action of influenza virus on the inhibitory urinary mucoprotein, Gottschalk[6] concluded that the carbohydrate component involved in this reaction has the structure of *iso*glucosamine. He defined the split product as N-1-deoxy-1-ketose amino-acid (lysine ?) or peptide. It is not yet clear what relation Gottschalk's product bears to sialic acid. (Preliminary experiments, however, indicate that a substance obtained by Gottschalk's procedure gives the colour reactions characteristic of sialic acid.)

Inhibitory products obtained by us from egg-white, ovomucin[7], allantoic fluid[8], ovarian cysts[8], follicular fluid from cows[8], and cancer fluid[9], were all found to contain sialic acid. Both the cancer fluid and the contents of one of the cysts showed very strong inhibitory activity, and no other carbohydrate (except hexosamine) was found to be present in appreciable amounts. This might suggest that sialic acid is of fundamental importance for the inhibitory reaction and may bear some relation to the receptor substance of erythrocytes. This suggestion is supported by the fact that a great many materials reported in the literature as containing hæmagglutination inhibitors have also been found to contain sialic acid; for example, blood serum, some plasma glycoproteins[3], human tears[8], cow's milk[8], epithelial mucins of various origins[8], human saliva[9], and meconium[9]. No quantitative relation, however, has been found between the content of sialic acid and the inhibitory activity of the different products examined. Thus a preparation of submaxillary mucin from cattle has a high content of sialic acid but a very low inhibitory activity, whereas allantoic fluid has a low sialic acid content and a high activity. Pure sialic acid has no activity at all.

It is then evident that if substances giving the characteristic reactions of sialic acid are concerned in the inhibition of virus hæmagglutination, either finer structural differences in the carbohydrate group or the properties of the accompanying protein component must be the determining factors for the inhibitory activity.

It was agreed with Dr. A. Gottschalk, of the Walter and Eliza Hall Institute of Medical Research, Melbourne, who is also investigating the carbohydrate components of the hæmagglutination-inhibiting mucoprotein from urine, to submit to *Nature* independently but simultaneously a summary of our results.

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[1] Tamm, I., and Horsfall, F. L., *Proc. Soc. Exp. Biol. and Med.*, **74**, 108 (1950).
[2] Tamm, I., and Horsfall, F. L., *J. Exp. Med.*, **95**, 71 (1952).
[3] Werner, I., and Odin, L., *Acta Soc. Med. Upс.*, **57**, 230 (1952).
[4] Blix, G., Svennerholm, L., and Werner, I., *Acta Chem. Scand.*, **6**, 358 (1952).
[5] Blix, G., *Z. physiol. Chem.*, **240**, 43 (1936).
[6] Gottschalk, A., *Nature*, **167**, 845 (1951).
[7] Odin, L., *Acta Chem. Scand.*, **5**, 1420 (1952).
[8] Odin, L. (unpublished investigations).
[9] Werner, I. (unpublished investigations).

Indicator Spray for Amino-Acids

In quantitative one-dimensional paper chromatography of amino-acids, the position of the various bands is generally determined either by running reference strips on the edges of the paper or by spraying lightly with weak ninhydrin solution. Neither method is entirely satisfactory. Reference strips are not always a reliable guide to cutting, particularly if the bands are close together, since the fronts may not be straight; the use of ninhydrin must give rise to some loss, which will fall most heavily on the acids present in least amount.

In this laboratory, we determine the individual acids manometrically following oxidation, and have developed an indicator spray which shows the position of the bands and does not interfere with the subsequent analysis. The spray consists of an alkaline alcoholic solution of bromothymol blue incorporating formaldehyde, so that, on the principle of the formol titration, the amino-acids appear as acid (yellow) bands against an alkaline (blue) background. The paper gradually fades to a uniform yellow colour; but the bands can, if necessary, be marked with a ball-point pen for subsequent cutting.

The spray has been used successfully for some time now, generally following a neutral solvent such as propanol–water, so that there is no trouble from residual acidity or alkalinity on the paper which, for quantitative work, is air-dried without application of heat. The spray solution is prepared by adding 3 ml. formalin and 0·1 ml. 60 per cent aqueous potassium hydroxide to 20 ml. 0·15 per cent (w/v) solution of bromothymol blue in 95 per cent alcohol.

The indicator appears to be almost as sensitive as ninhydrin, particularly for the shorter-chain amino-acids; but the bands tend to be somewhat narrower, and, when cutting for quantitative work, a little of the paper on either side of the band should be included.

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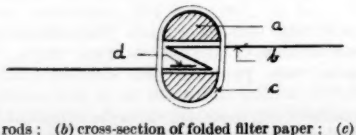
Application of Material in Filter Paper Chromatography

In order to obtain a good separation in filter paper chromatography, the size of the spot of liquid applied to the paper must be small, which often necessitates repeated, time-consuming applications of material. Methods have been evolved with the purpose of having spots or a band laid down automatically by a burette[1,2]. There still seems to be a need, however, for a technique by which a larger volume of fluid can be deposited quickly and simply, yet permitting small-sized bands or spots for good separation.

We have used the following procedure. The fluid material is deposited on a strip of filter paper 2–5 mm. in width according to the degree of separation wanted. The filter paper strip, after drying, is placed in a z-shaped fold of the filter paper sheet. The size of the fold is slightly larger than the strip (see diagram). In this way the strip carrying the substance to be chromatographed is covered by the filter paper sheet on both sides. The fold is kept closed by the application, on each side of the sheet, of glass rods ground plane on one side or by glass plates of some 5 mm. width and 1·5 mm. thickness. The glass rods or plates are held together on each side of the paper with rubber bands exerting a slight pressure. The filter paper strip should not reach the margin of the sheet but leave 0·5–1 cm. on each side.



(*a*) Glass rods; (*b*) cross-section of folded filter paper; (*c*) rubber band keeping the fold closed; (*d*) filter paper strip carrying the material

The filter paper strip can, according to its size, absorb an amount of fluid of 5–10 c.mm. per cm. at each application. After drying, additional amounts of fluid can be applied.

In order to facilitate application of a total of 0·5–1 ml. fluid on a filter paper strip, the strip is placed on the flat floor of a small 'Lucite' trough holding 1–2 ml. and with sloping walls. The solution is easily dried up on the paper in the desiccator. It is preferable to treat the trough and glass plates with some anti-wetting compound. In this way a given extract concentrated to a suitable volume can be absorbed quantitatively by the strip, dried and subjected to chromatography in a short time.

The separation is satisfactory if a filter paper strip (2·5 mm. × 40 mm.) which has absorbed in one stage 0·02 ml. of a solution containing 1 mgm. adrenaline and 1 mgm. noradrenaline per ml. (ascending run, 15 hr. in phenol/0·1 *N* hydrochloric acid) is used.

The method has proved adequate with Grycksbo *OB* paper, but is not suitable for the harder papers such as Whatman No. 1 or 4.

We have found no difference in result if the paper strip is placed in one or the other of the two folds.

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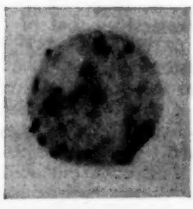
[1] Urbach, K. F., *Science*, **109**, 259 (1949).
[2] Yanofsky, Ch., Wasserman, E., and Bonner, D. M., *Science*, **111**, 61 (1950).

Demonstration by Radioactive Tracers of the Adsorption of Cations by Metals

The electromotive force of a primary electric cell is still explained by Nernst's theory, which only considers the case of a metal and its own cations. We have developed a more general theory[1], based on the hypothesis that the electrode potentials are due to the adsorption of cations. To emphasize the difference between the two theories, it is only necessary to say that, according to our view, all the individual potentials ought to be negative.

Experiments carried out in our laboratory, which will be published in due course, show that every metal has a selective adsorption power in the sense that if the electrolyte contains several kinds of cations, though all of them contribute to the potential of the electrode, only the active ones are adsorbed. It seems, moreover, that in some cases ions from the metal go into the solution and are replaced by an equivalent number of active cations.



Autoradiograph of an aluminium foil after 12 days immersion in a 0·27-*M* solution of activated zinc sulphate. It shows that only isolated domains are active. Similar results have been obtained with copper, lead, iron and nickel

The direct proof for the exchange of cations has been obtained with radioactive tracers. A sample from the Atomic Energy Research Establishment, Harwell, containing 5 gm. of irradiated zinc converted into zinc sulphate, with an activity of 7 mC. due to zinc-65, was diluted so as to obtain a solution of 0·27 molarity. Metals in the form of wires, of about 25 mm. length and 0·55 mm. diameter, were immersed in separated portions of such a solution and, after thorough washing, were tested with a Geiger–Müller counter, with the aid of a sample changer which makes it possible to reproduce the geometrical conditions very accurately. Table 1 shows the results, corrected for the background counting rate, after 7 days immersion.

Table 1

Metal	Pt	Pd	Au	Ag	Cu	Fe
Counting-rate per min.	15	128	241	330	159	889

The effect, which is rather small with platinum, becomes very striking with all other metals. We consider this result as a proof that in the first case there is pure adsorption, whereas in the second, adsorption is followed by exchange of cations.

With foils instead of wires, it has been possible to compute the total number of atoms of zinc, radioactive and not radioactive, taken by each square centimetre. The results obtained with lead are given in Table 2. Copper and nickel have shown similar behaviour.

Table 2

Concentration	Time of immersion	Atoms per sq. cm.
0·27 *M*	1 hr.	$4·1 \times 10^{14}$
"	22 hr.	11·3 "
"	22 days	8,800 "
0·0027 *M*	22 hr.	7·5 "
"	22 days	200 "

Autoradiographs obtained with foils activated by immersion in the solution of radioactive zinc show that the exchange of cations takes place in small and separated portions of the surface; thus, the so-called local effect has been made visible.

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[1] Palacios, J., *Rev. Fac. Ciencias de Lisboa*, (2), B, **1**, 1 (1950).

Ion-Exchange Elution Series

A comparison of the efficiency of various eluants in ion-exchange separations of the lanthanons[1] has led to the hypothesis that the relative values of eluants (and the optimum conditions of their employment) may be simply related to the overall stability constants of the complexes formed between the lanthanon ions and the eluting agent.

Comparison of eluants apart, however, the argument entails that the sequence of stability values ($\log \bar{K}$) of lanthanum eluant complexes should coincide with the elution sequence. This has been confirmed not only for tervalent lanthanon ions but also for bivalent metal ions. However, in systems of mixed bi- and ter-valent ions, although the elution sequence for ions of the same charge remains the same, the elution series of the mixed ions is out of conformity with the stability series for the mixed ions. Thus, the stability series for ethylenediamine tetra acetic acid complexes is[1,2]:

Ion	log $\overline{K}$	Ion	log $\overline{K}$	Ion	log $\overline{K}$
Yb^{3+}	18·70	Sm^{3+}	17·20	Co^{2+}	16·10
Ni^{+}	18·45	Nd^{3+}	16·75	Ce^{3+}	16·05
Cu^{2+}	18·38	Pr^{3+}	16·55	La^{3+}	15·30
Pb^{2+}	18·20	Cd^{2+}	16·48	Fe^{2+}	14·22
E^{3+}	18·15	Zn^{2+}	16·15	Mn^{2+}	13·47
Y^{3+}	18·00				

The elution sequence, however, is :

Ni, Cu, Yb, Y, Dy, Cd, Eu, Zn, Sm, Co, Fe, Nd, Mn, Pr, La[1].

Similarly, with nitrilotriacetic acid complexes, some log $\overline{K}$ values are :

Cd, 9·54 ; La, 10·37 ; Pr, 11·7 ; Sm, 12·4.

Fitch and Russell[3] find that cadmium is interpolated between neodymium and samarium. These interpolations, of manganese between praseodymium and neodymium, and of cadmium between neodymium and samarium, while of great use in lanthanon separations[1,2], introduce two possible amendments to the case for a simple relationship of stability constants and eluant efficiencies : (*a*) that the stability series determined through potentiometric titrations of the complex system do not hold in ion-exchange systems, because of the formation of different complex species ; or (*b*) that the stability series varies because of a factor influenced by the valency of the ions.

Since log $\overline{K}$ values are overall constants and take account of a multitude of complex species, alternative (*a*) is scarcely tenable. An examination of the second factor has, however, confirmed that a preponderance of tervalent ions induces an apparent increase in the stabilities of bivalent ion complexes and vice versa. Thus, with ethylenediamine tetra acetic acid solutions as the eluant, the experimentally determined series are as follow :

With preponderance of bivalent ions :
Yb, Er, Ni, Cu, Sm, Nd, Pr, Ce, La, Cd, Co, Fe, Mn.

With preponderance of tervalent ions :
Ni, Yb, Y, Cd, Eu, Zn, Sm, Fe, Nd, Mn, Pr, La.

With equivalence of bi- and ter-valent ions :
Yb, Ni, Pb, Er, Sm, Nd, Pr, Cd, Co, La, Fe, Mn.

This phenomenon does not appear to have been recorded hitherto and is being further studied.

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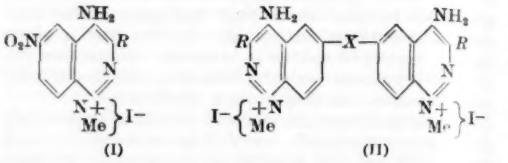
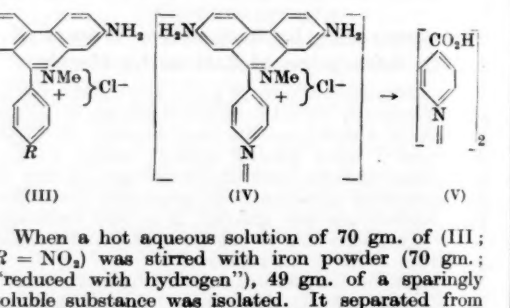
[1] Vickery, *J. Chem. Soc.* (in the press).
[2] Schwarzenbach and Freitag, *Helv. Chim. Acta*, **34**, 1492, 1503 (1951).
[3] Fitch and Russell, *Anal. Chem.*, **23**, 1469 (1951).

Reduction of Nitrophenanthridinium Salts : Influence of Molecular Size on Trypanocidal Activity

In 1948 Kenneford, Lourie, Morley, Simpson, Williamson and Wright[1] reported that the crude reduction products of the cinnolinium salts (I ; R = H or Me) showed considerable activity in infections of *Trypanosoma congolense* in mice, whereas the pure diamino-salts were inactive. They attributed this phenomenon to the probable presence in the crude products of azo-compounds (II ; X = —N=N—) of high trypanocidal activity. It has recently[2] been further demonstrated that structures of the general formula (II), where X may have values other than —N=N—, have trypanocidal properties, the most effective being '528' (II ; R = H, X = —NH.C(=NH)—).



One of us (L. P. W.) has long used iron powder for the reduction of nitrophenanthridinium salts in aqueous solution to amino-salts, and has observed[3] that sparingly soluble by-products are frequently formed, although usually in very small amount. In the reduction of 2-amino-10-methyl-9-*p*-nitrophenylphenanthridinium chloride, however, a crystalline by-product was isolated[4], and the reduction of 2 : 7-diamino-10-methyl-9-*p*-nitrophenylphenanthridinium chloride (III ; R = NO_2) by iron–water is so unsatisfactory that this reagent was replaced by ferrous hydroxide–water[5], which is a much better reagent for the reduction of nitro-quaternary salts. In 1949, a quantity of the powerful trypanocide (III ; R = NH_2) was required for field trials, and we decided to re-examine the iron–water reduction of (III ; R = NO_2).



When a hot aqueous solution of 70 gm. of (III ; R = NO_2) was stirred with iron powder (70 gm. ; "reduced with hydrogen"), 49 gm. of a sparingly soluble substance was isolated. It separated from its purple solution in hot water as a gel, which slowly changed to a mass of microscopic black plates, but crystallized from methanol in black prisms, which are purple by transmitted light, unmolten at 350°. A small quantity of (III ; R = NH_2) was isolated with difficulty. The new substance is undoubtedly the azo-salt (IV) (found for dried salt : C, 69·4 ; H, 4·85 ; N, 16·0 ; Cl, 10·4. $C_{40}H_{34}N_8Cl_2$ requires C, 68·9 ; H, 4·9 ; N, 16·1 ; Cl, 10·2 per cent). Its light absorption resembles that of (III ; R = NO_2) rather than that of (III ; R = NH_2), supporting the presence of the chromophore —N=. It was oxidized readily in aqueous solution by permanganate, affording a good yield of 4 : 4′-azobenzenedicarboxylic acid (V), which was identified as its ethyl ester with an authentic specimen. Under similar conditions (III ; R = NO_2) gave 4-nitrobenzoic acid. The azo-salt is converted by dilute hydrochloric acid into a crystalline rust-coloured hydrochloride, which is rapidly hydrolysed by water or alcohol to the original salt.

There appears to be no adequate analogy to the facile reduction of a nitro- to azo-compound, which occurs in this and presumably the cinnoline series, and the explanation is probably to be found in the fact that both reactant and product are present in aqueous solution. The azo-compound is unlikely to be an intermediate in the reduction to amine, for it is highly resistant to further reduction. More probably the nitroso-compound is intermediate and, if it is not itself rapidly reduced further to amine, condenses with amine already present. The proportion of amine (III ; $R = NH_2$) formed appears to increase at the expense of (IV) as the efficiency of stirring improves, and this suggests that for reduction of (III ; $R = NO_2$) to (III ; $R = NH_2$) an adequate concentration of ferrous ions is required throughout the reaction solution. With a colloidal suspension of ferrous hydroxide this condition is more likely to be fulfilled, and (IV) is therefore not produced. This explanation is, of course, incomplete in that it does not account for the great variation of yield of azo-salt from different nitro-quaternary salts.

In view of the results of Lourie and his collaborators and the known efficacy of 'double' molecules as trypanocides[2], our biological results with (IV) are of considerable interest. Against *T. congolense* in mice it is only one-hundredth as active as either (III ; $R = NO_2$) or (III ; $R = NH_2$), these results being in striking contrast to those obtained by 'doubling' the aminoquinoline or aminocinnoline molecules. On the other hand, it exerts a more prolonged prophylactic action in mice than any other phenanthridinium salt we have examined, and its toxicity by the subcutaneous route is low, mice surviving a subcutaneous dose of 1 gm. per kgm. body-weight for ten days. These results suggest slow absorption, perhaps due to depot formation ; but other properties of (IV) do not necessarily support such an explanation. Thus its solubility in water (6 gm. per litre at 20°) is practically the same as that of (III ; $R = NO_2$), and its activity against *T. rhodesiense* in mice amounts to one-third of that of (III ; $R = NH_2$), which is the most active member of the series yet known against this species. Thus against *T. rhodesiense* the activity of (IV) ranks high in the series[6]. That (IV) separates from aqueous solution as a gel suggests that the solution is colloidal, and it is significant that the notable prophylactic properties of suramin, which also is a large molecule, have been attributed *inter alia* to the colloidal nature of its solution. It is possible also that (II) and (III) represent optimum molecular patterns for *T. congolense* activity, and that the area of the molecules is critical.

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[1] Kenneford, J. R., Lourie, E. M. Morley, J. S., Simpson, J. C. E., Williamson, J., and Wright, P. H., *Nature*, **161**, 603 (1948).
[2] Lourie, E. M., Simpson, J. C. E., and Walker, J. M., *Brit. J. Pharmacol.*, **6**, 643 (1951).
[3] Walls, L. P., *J. Chem. Soc.*, 299 (1945).
[4] Caldwell, A. G., and Walls, L. P., *J. Chem. Soc.*, 193 (1948).
[5] Walls, L. P., and Whittaker, N., *J. Chem. Soc.*, 43 (1950).
[6] Brownlee, G., Goss, M. D., Goodwin, L. G., Woodbine, M., and Walls, L. P., *Brit. J. Pharmacol.*, **5**, 261 (1950).

Relation between Intrinsic Viscosity and Degree of Polymerization

It is generally agreed that the relation between intrinsic viscosity and degree of polymerization (D.P.), for the majority of polymer systems, is of the form $[\eta] = K\,(\text{D.P.})^{\alpha}$; but there appears to be no slackening in the controversy as to the numerical values of K and α for a particular system. Most of the values have been obtained from measurements of the intrinsic viscosity and osmotically determined degree of polymerization on nearly homogeneous fractions. Apart from experimental error, there is a number of ways in which discrepancies can arise. High intrinsic viscosities may not be free from the influence of the non-Newtonian behaviour of the solutions from which they are derived ; fractions may not be sufficiently homogeneous ; and membranes may not be strictly semi-permeable[1].

There is, however, an additional source of error, more often than not neglected. It has been pointed out[2] that in osmometry the osmotic pressure in cm. of water is not simply the difference in height between the menisci of the solution and solvent, multiplied by the density of the solution ; it is actually the difference in pressure between the column of solvent and the column of solution, when the column length is measured from the centre of pressure of the cell, in the case of a vertical membrane, or from the membrane, when it is horizontal, to the meniscus. For dilute solutions, the correction to be added requires an approximate measurement of the vertical distance between the solvent meniscus and the centre of the membrane, and a knowledge of the densities of the solvent and solution.

The correction is much larger for the Fuoss–Mead[3] than for the Schulz[4] osmometer. For a solution of given concentration in a particular osmometer, the correction to the osmotic pressure is of the same order whatever the degree of polymerization of the solute. The effect on the absolute value of the osmotic pressure is then greatest for solutes of high degree of polymerization, and hence the relation between intrinsic viscosity and degree of polymerization is altered.

The relation between the intrinsic viscosity (dl./gm.) in butyl acetate at 25° C., and the degree of polymerization, measured in an osmometer of the Fuoss–Mead type, has recently been determined in these laboratories for a series of fractions of cellulose nitrate, containing 14 per cent of nitrogen, derived from viscose rayons and covering the range of degrees of polymerization from 100 to 1,800. The uncorrected values for K and α were 0·0154 and 0·93 respectively, but on making the correction they became 0·0108 and 1·0. This startling change stresses the importance of the density of the solution in osmotic pressure measurements.

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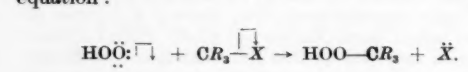
[1] Philipp, H. J., and Bjork, C. F., *J. Polymer Sci.*, **6**, No. 4, 383 (1951).
[2] Boissonnas, C. G., and Meyer, K. H., *Helv. Chim. Acta*, **20**, 783 (1937). Higginbotham, R. S., Shirley Institute Mem., **24**, 221 (1950) ; or, *J. Text. Inst.*, **42**, No. 6, T235 (1951). Gilbert, G. A. Graff-Baker, C., and Greenwood, C. T., *J. Polymer Sci.*, **6**, No. 5, 585 (1951). Lang, H., *Kolloid-Z.*, **122**, 165 (1951).
[3] Fuoss, R. M., and Mead, D. J., *J. Phys. Chem.*, **47**, 59 (1943).
[4] Schulz, G. V., *Z. physik. Chem.*, A, **176**, 317 (1936).

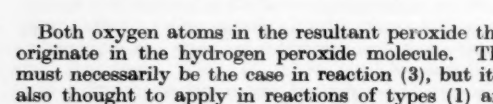
Preparation of Alkyl Hydroperoxides

Alkyl hydroperoxides have been prepared by the action of hydrogen peroxide on: (1) alkyl sulphates, R_2SO_4, in the absence (for example, $R = Bu^t$)[1] or presence (for example, $R = Et$)[2] of alkali; (2) tertiary alcohols in the presence of a trace of concentrated sulphuric acid[3]; (3) triphenylmethyl halides[4,5]. All these reactions may be interpreted as involving nucleophilic attack of the HOOH molecule or HOO^- ion on a carbon atom according to the general equation:

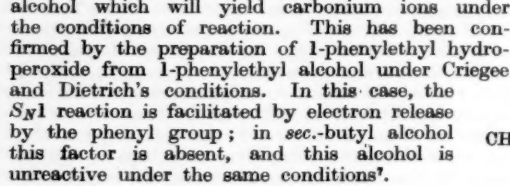


Both oxygen atoms in the resultant peroxide thus originate in the hydrogen peroxide molecule. This must necessarily be the case in reaction (3), but it is also thought to apply in reactions of types (1) and (2). The reaction may proceed by either of the two established mechanisms of nucleophilic substitution (the S_N1 and S_N2 mechanisms), and variation in constitutional and environmental factors will produce the usual effects[6]. Characteristic stereochemical consequences may be expected; for example, partial or complete racemization should accompany mechanism S_N1.

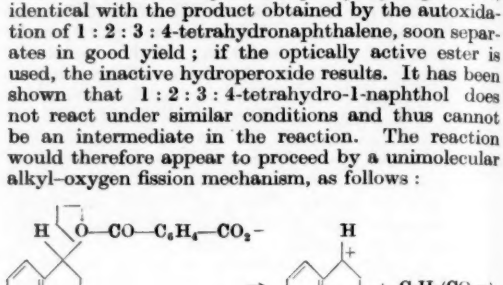
Criegee and Dietrich[3] state that primary and secondary alcohols do not react under the conditions of reaction (2). This reaction probably occurs readily with tertiary alcohols because inductive and hyperconjugative electron release by the alkyl groups, in conjunction with acid catalysis, facilitates the production of a carbonium ion which is then attacked by the hydrogen peroxide to give the alkyl hydroperoxide (the S_N1 mechanism).



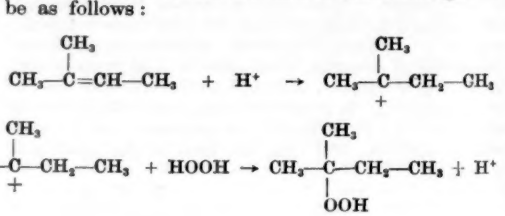
The reaction should, therefore, not be restricted to tertiary alcohols, but should apply to any alcohol which will yield carbonium ions under the conditions of reaction. This has been confirmed by the preparation of 1-phenylethyl hydroperoxide from 1-phenylethyl alcohol under Criegee and Dietrich's conditions. In this case, the S_N1 reaction is facilitated by electron release by the phenyl group; in *sec.*-butyl alcohol this factor is absent, and this alcohol is unreactive under the same conditions[7].



Hydroperoxides should also be produced by other types of compounds which are capable of the production of alkyl cations. Thus a carboxylic ester which readily undergoes alkyl–oxygen fission should be perhydrolysed to give an alkyl hydroperoxide and a carboxylic acid. This reaction has been established in the case of the hydrogen phthalate of 1 : 2 : 3 : 4-tetrahydro-1-naphthol. This ester has been shown to have a tendency to react by an alkyl–oxygen fission mechanism: for example, the optical activity of the alcohol obtained by hydrolysis of the ester decreases with decreasing nucleophilic power of the hydrolytic reagent, and the alcohol itself readily forms a sulphone with *p*-toluenesulphinic acid[8]. It has now been found that when 1 : 2 : 3 : 4-tetrahydro-1-naphthyl hydrogen phthalate is dissolved in 90 per cent hydrogen peroxide containing sodium bicarbonate, 1 : 2 : 3 : 4-tetrahydro-1-naphthyl hydroperoxide, identical with the product obtained by the autoxidation of 1 : 2 : 3 : 4-tetrahydronaphthalene, soon separates in good yield; if the optically active ester is used, the inactive hydroperoxide results. It has been shown that 1 : 2 : 3 : 4-tetrahydro-1-naphthol does not react under similar conditions and thus cannot be an intermediate in the reaction. The reaction would therefore appear to proceed by a unimolecular alkyl–oxygen fission mechanism, as follows:



The addition of a proton to an olefine will also produce an alkyl cation, which should react with hydrogen peroxide to lead to the formation of an alkyl hydroperoxide. This has been confirmed in the case of 2-methylbut-2-ene. This olefine, when stirred for 18 hr. with 90 per cent hydrogen peroxide in the presence of a trace of concentrated sulphuric acid, gives a good yield of *tert.*-amyl hydroperoxide. The mechanism of this reaction is hence thought to be as follows:



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[1] Milas and Surgenor, *J. Amer. Chem. Soc.*, **68**, 205 (1946).
[2] Baeyer and Villiger, *Ber.*, **34**, 738 (1901).
[3] Criegee and Dietrich, *Annalen*, **560**, 135 (1948).
[4] Wieland and Maier, *Ber.*, **64**, 1205 (1931).
[5] Bartlett and Cotman, *J. Amer. Chem. Soc.*, **72**, 3095 (1950).
[6] Hughes, Ingold and co-workers, summarized by Hughes, *Trans. Farad. Soc.*, **37**, 603 (1941).
[7] Davies and Foster (unpublished).
[8] Davies and White, *J. Chem. Soc.*, 3300 (1952).

Nature of the 'Induction Period' in the Preparation of Lithium Aluminium Hydride

For the preparation of lithium aluminium hydride, Schlesinger *et al.*[1] claim that an addition of lithium aluminium hydride to the ether covering the powdered lithium hydride is essential. In absence of it a smooth reaction between lithium hydride and aluminium chloride was not always possible, and a period of induction ranging from a few minutes to several hours followed. Such induction periods were undesirable as they made the reaction uncertain and also difficult to control once it began again. To overcome this difficulty, Schlesinger *et al.* give two elaborate methods for making lithium aluminium hydride for subsequent catalytic use. These methods unfortunately involve complicated apparatus which is difficult to find, if at all, in most laboratories.

Thus when making lithium aluminium hydride, owing to the non-availability of lithium aluminium hydride for catalytic purposes, the reaction was tried without the addition of lithium aluminium hydride to ether covering powdered lithium hydride. It was noticed that the reaction always started immediately and continued smoothly to the end. In view of these observations it was difficult to understand the difficulty encountered by other authors until the following clue was obtained.

Once, while making lithium aluminium hydride by the usual method (that is, without the addition of lithium aluminium hydride), the reaction failed to start and an induction period lasting for twelve hours followed. When the reaction was conducted on a portion of lithium hydride from the same source, but with an addition of lithium aluminium hydride to ether covering it, the reaction went smoothly. This proved conclusively that there was something in ether that was responsible for the induction period and that it was removed or destroyed by lithium aluminium hydride. A portion of the ether was therefore distilled over lithium aluminium hydride and then used in the preparation of hydride. The reaction went smoothly. The same effect was produced when ether was carefully dried again over sodium. In view of these results, it was clear that the induction period was caused by inactivation of lithium hydride powder, probably by water that remains in ether when not thoroughly dry. This view fits in well with the fact that, whereas sodium wire takes a long time to remove the last traces of moisture owing to its surface reaction alone, lithium aluminium hydride, by virtue of its solubility in ether, can remove moisture spontaneously on mixing. The inactivation of lithium hydride may therefore lie in the formation of a protective film, probably of lithium hydroxide, on the surface of its particles, and the induction period may well be the time required to remove this film by chemical and mechanical means. Once this unreactive coating is removed, a vigorous reaction is conceivable in presence of a large amount of aluminium chloride in ether.

In view of these observations, it can be stated that it is desirable to add lithium aluminium hydride for catalytic purposes; but in absence of it, a smooth reaction can be ensured by using carefully dried ether.

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[1] Schlesinger *et al.*, *J. Amer. Chem. Soc.*, **69**, 1199 (1947).

Intensification of the Latent Photographic Image produced by Beta-Rays

It is known that a latent image produced by a brief exposure to light can be intensified by a post-exposure to light of low intensity. This fact can be explained by assuming the production of a non-developable latent sub-image in addition to the normal latent image which can be developed. The latent sub-image can be converted to a developable latent image by a carefully controlled post-exposure to light of low intensity.

As the photographic action of charged particles on an emulsion is basically the same as that of light, it is to be expected that a latent sub-image is also produced by these particles. It is also to be expected that this latent sub-image would be produced in quantity when a fine-grain emulsion is exposed to fast particles of low charge, for example, if β-rays fall on plates which are not very sensitive to these rays.

We had available Kodak *NT 2 A* plates and a source of 0·01 μC. radium-D from the Atomic Energy Research Establishment, Harwell. This source was filtered by 10 mgm./cm.^{2} aluminium, so that only the β-rays from radium E were effective. The middle part of the plates was exposed to the β-rays for 1–2 days. After this exposure, half the plate was exposed to light from a 6·5-V. 0·2-amp. lamp at a distance of 2 m. for 20–28 sec. The plates were developed with *D* 19.

The density produced by the post-exposure alone varied from 0·007 to 0·11. For all post-exposures an increase of density of 50–100 per cent over that without post-exposure was obtained. Pre-exposure gave no appreciable effect. This agrees with the general rule that intensification can only be obtained if a long low-intensity exposure follows a short high-intensity exposure. The exposure of a grain hit by a β-ray is, of course, very intense and short in time.

Fuller details of this work will be published in due course in the *Revue de la Faculté des Sciences de l'Université d'Istanbul.*

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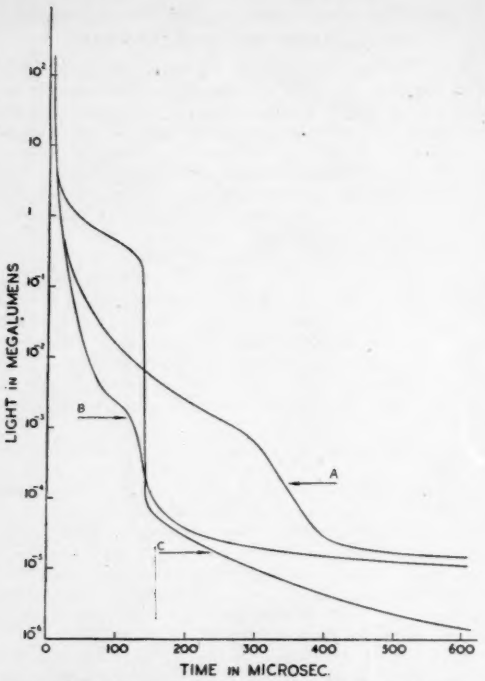
Decay of Light to Very Low Levels from Spark Discharges

Recent publications on the after-effects from the electrical explosion of wires[1] and in Geiger counters[2], the cold emission of electrons in spark gaps[3] and the light output of sparks[4] suggest that the following experiments may be of interest, as we have not seen comparable results reported elsewhere.

We have observed the decay of light from pulsed high-current discharges in several gases and liquids down to extremely low levels and extending for several hundred microseconds. Single, approximately rectangular, current pulses obtained from a condenser network charged to 10 kV., of 1–9 μsec. duration and 100–10,000 amp. peak value, were used with electrode separation of a few millimetres. Triggering was effected by means of a trigger pulse applied to an auxiliary electrode. The light output was detected by means of an *RCA* 931*A* photomultiplier cell, amplifier and oscillograph. By altering the high



Decay of light from pulse discharges, 6,000 amp. peak and 6 μsec. duration: (*A*) in air, (*B*) in a rapid air stream, and (*C*) in water at 60 atm. pressure

tension of the cell and by the use of optical filters, the range of light output that could be measured was greater than 10^8 to 1, and the recovery time of the system from saturation due to the peak light was only about 20 μsec.

The types of decay curves obtained under various conditions are shown in the accompanying graph. Curve *A* is for a 6,000-amp. discharge between steel electrodes in air. The light decays very rapidly to about 10^{-4} of peak in the first 100 μsec. The rate of decay afterwards is much slower until a level of about 10^{-7} of peak is reached at 400 μsec., and this level is then maintained nearly constant to at least 600 μsec. This persistence of light at a low level is not due, apparently, to excited atoms remaining in the gap, as when the gap is swept by a powerful air blast only the initial rate of decay is changed, as shown in curve *B*. A similar curve is also obtained when possible direct radiation from the electrodes is screened off from the cell.

It was also found that the shape of the light decay curve is not significantly affected by the value of the peak current over the range investigated, but a slightly slower decay-rate is obtained when the pulse length is increased from 2 to 9 μsec. Slower initial decay-rates are obtained when the more volatile metals, such as aluminium, are used for the electrodes. Results similar to the air spark are obtained from discharges in photographic flash tubes, designed for a flash of a few microseconds duration, and in trigatrons.

Similar effects have also been observed with discharges in water; but in this case the initial rate of decay showed a marked increase when the water was subjected to considerable pressure, presumably due to the quicker collapse of the vapour bubble formed by the discharge. This effect is shown by curve *C* for a pressure of 60 atmospheres.

In all cases tried, light is still being emitted at a level of 10^{-7}–10^{-8} of peak some 600 μsec. after the current pulse, and this is not materially influenced by the conditions of the discharge. It is possible that ionization produced by continued electron emission from the cathode may account for this effect, and further study may yield new information on the processes involved. It is hoped to publish more detailed results in due course.

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Radar Research and Development Establishment, Malvern, Worcs. April 24.

[1] Conn, W. M., *Nature*, **169**, 150 (1952).
[2] Wiedenbeck, M. L., and Crane, H. R., *Phys. Rev.*, **75**, 1268 (1949).
[3] Jones, F. Ll., and de la Perrelle, E. T., *Nature*, **168**, 160 (1951). Haworth, F. E., *Phys. Rev.*, **80**, 223 (1950).
[4] Standring, W. G., and Looms J. T. S., *Nature*, **165**, 358 (1950).

Rotational Analysis of the Columbium Oxide Bands

The bands of columbium oxide have been photographed on a 21-ft. concave grating with 30,000 lines per inch. The rotational analysis of three of these bands, λ 4,510 (1,0), λ 4,689 (0,0) and λ 4,915 (0,1) has been carried out. The rotational structure is found to resemble very closely that of vanadium oxide. Two *R* and two *P* branches have been identified in each band. The following constants have been determined for the ground and excited states:

$B_e' = 0{\cdot}5395$ cm.$^{-1}$	$B_e'' = 0{\cdot}6557$ cm.$^{-1}$
$B_0' = 0{\cdot}5325$ cm.$^{-1}$	$B_0'' = 0{\cdot}6553$ cm.$^{-1}$
$B_1' = 0{\cdot}5185$ cm.$^{-1}$	$B_1'' = 0{\cdot}6545$ cm.$^{-1}$
$\alpha' = 0{\cdot}0140$ cm.$^{-1}$	$\alpha'' = 0{\cdot}0008$ cm.$^{-1}$
$I_e' = 50{\cdot}32 \times 10^{-40}$ gm.cm.^{2}	$I_e'' = 42{\cdot}18 \times 10^{-40}$ gm.cm.^{2}
$r_e' = 2{\cdot}237 \times 10^{-8}$ cm.	$r_e'' = 1{\cdot}874 \times 10^{-8}$ cm.

The *D* values for the two states are of the order of 10^{-6} cm.$^{-1}$. Details of this work will be published elsewhere.

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Eye Rotations with Change of Accommodation

The apparatus, previously described[1], for studying eye movements of subjects in the sitting position, has been expanded so that side-to-side and up-and-down movements of the right eye can be recorded simultaneously. Rotations of this eye, occurring when accommodation is changed, have been studied with the apparatus. In these experiments, two fixation targets were used; both lay on the visual axis of the right eye when this eye was looking straight ahead. The farther target, which was viewed through a glass plate, was a bright pin-hole, angular diameter 1′, distant 5½ ft. from the subject. The nearer target was the mid-point between two virtual images, formed by reflexion at the front and rear surfaces

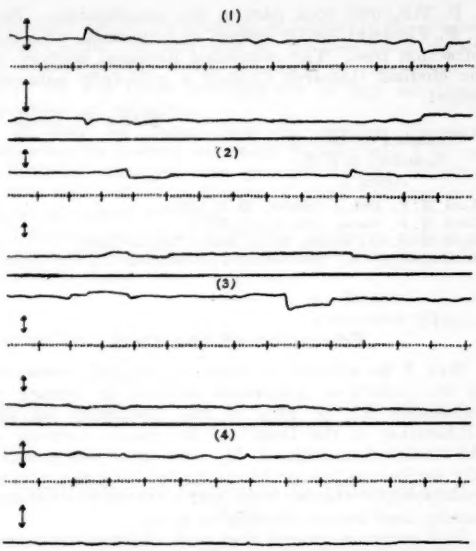
of the glass plate, of another bright pin-hole. The virtual images were 2 ft. from the subject and the separation between them was 23′. Records were obtained for both horizontal and vertical separations of the virtual images. The subject fixated the far and near targets alternately; this cycle was repeated several times during a single recording, the frequency being at the subject's discretion. Records were obtained for both binocular and right-eye viewing of the targets.

As in the case of subjective change of convergence[2], change of accommodation was found to be associated with head movements similar to those occurring during steady fixation. Records for subjects R. S. L. and J. P. T. are independent of the direction of separation of the virtual images. It appears that change of accommodation is associated with a saccadic excursion of the eye, followed by return to its original fixation direction; saccadic movements are superimposed on the return drift in 50 per cent of the changes for J. P. T. and in 35 per cent for R. S. L. Characteristic records for R. S. L. for binocular viewing, and for J. P. T. for monocular viewing, are shown in Figs. 1 and 2 respectively. The average interval between changes is 1·7 sec. for R. S. L. and 1·6 sec. for J. P. T. For both subjects, the movements are oblique; for binocular viewing, the average magnitudes of the components for R. S. L. are 1·1° side to side, and 0·4° up and down; for J. P. T., they are 1·9° side to side, and 1° up and down. The monocular averages for R. S. L. are 0·8° side to side, and 0·3° up and down; for J. P. T., they are 1° side to side, and 0·7° up and down. For J. P. T., increase of accommodation is associated with a nasalward saccadic movement, and relaxation with a templeward saccadic movement. For R. S. L., the converse occurs for binocular viewing; for monocular viewing, nasalward saccadic movements are associated sometimes with increase, and sometimes with relaxation, of accommodation. The number of nasalward-upwards, nasalward-downwards, templeward-upwards and templeward-downwards saccadic rotations are approximately equal for J. P. T. For R. S. L., on the other hand, nasalward-upwards and templeward-downwards movements each comprise about 40 per cent of the saccadic rotations.

Injury to subject F. H. interrupted the investigation of his accommodation eye movements. However, the records obtained, which are for horizontal separations only of the virtual images, indicate qualitatively similar behaviour to that found for the other subjects. A characteristic record for F. H. is shown in Fig. 3.

Since the records are similar for the two directions of separation of the virtual images, it seems unlikely that there are any eye movements due to uncertainty of the subject about the position of the near fixation target. Moreover, steady fixation eye records[3] for such a target are similar to those for a single bright point.

For binocular viewing, Hering's[4] law predicts that, for the target configuration of this investigation, increase of accommodation would be accompanied by a nasalwards movement through about 2°, compounded with a templewards movement of equal magnitude. The behaviour of none of the subjects is in accord with this theory; in every case, the saccadic movements are oblique. Moreover, for subject R. S. L., the magnitude of the sideways component is smaller than that required by the theory. As for subjective change of convergence[2], the observed movements may be explained in terms of the energization, in activity, of the extra-ocular muscles.



(1) Right-eye record for binocular viewing for R. S. L.; separation of virtual images vertical.
(2) Right-eye record for right-eye viewing for J. P. T.; separation of virtual images horizontal.
(3) Right-eye record for binocular viewing for F. H.; separation of virtual images horizontal.
(4) Right-eye record for right-eye viewing for A. L.; separation of virtual images vertical.
In Figs. 1–3, the movement at the extreme left of the record corresponds to increase of accommodation.
Side-to-side records are above the time-line; towards the time-line corresponds to nasalwards.
Up-and-down records are below the time-line; towards the time-line corresponds to upwards.
Time (increasing to right) |.....| represents 0·2 sec.
Height of arrowed line represents a rotation of 3°, assuming the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

Since most visual experience is binocular, an eye is accustomed to rotate when a change of its accommodation only is required. It is therefore not surprising that right-eye movements, on changing accommodation, should persist even when the left eye is screened; the movements are, however, somewhat smaller than those for binocular viewing, and, for R. S. L., are not always in the same direction.

To investigate whether eye rotations on changing accommodation arise entirely from binocular visual experience, records have been obtained for a subject whose visual experience is effectively monocular. The right eye of this subject, A. L., is emmetropic, acuity 6/4; with a correction of 1·5 *D* sph. combined with a $-$ 2·5 *D* cyl. (axis 15°), the left eye acuity is 6/18. A. L. has never worn glasses, and normally the left-eye vision is suppressed. His records are independent of the direction of separation of the virtual images, but otherwise differ considerably from those previously described; a characteristic record is shown in Fig. 4. The records for monocular and binocular viewing are similar and are little different from steady fixation records. It thus seems likely that binocular visual experience is entirely responsible for eye movements associated with change of accommodation, and that the precise nature of the movements depends on the energization, in activity, of the extra-ocular muscles.

I am grateful to Dr. R. S. Longhurst for acting as subject and for interesting discussions; and also to my students, Messrs. F. Hodgson, A. Langridge and

J. P. Tilt, who took part in the investigation. Mr. E. F. Fincham kindly helped in connexion with the refraction test. The continued financial support of the Medical Research Council is gratefully acknowledged.

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[1] Lord, M. P., *Brit. J. Ophthal.*, **35**, 21 (1951).
[2] Lord, M. P., *Nature* [**169**, 1011 (1952)].
[3] Lord, M. P., and Wright, W. D., *Nature*, **162**, 25 (1948).
[4] Duke-Elder, W. S., "Text Book of Ophthalmology", **1**, 602 (1932).

Education of the Deaf

May I be allowed to make a material correction to the otherwise admirable account in *Nature* of September 27, p. 525, of the discussion on the "Education of the Deaf" at the recent meeting of the British Association? My own paper was specifically limited to the problem of educating the young, totally deaf—whether born deaf, or those who become totally deaf before learning to speak.

It is common ground that such children constitute a very difficult problem. Mr. Greenaway reported that of twenty deaf pupils leaving his school this year, 60 per cent could be considered as successes, but the remaining 40 per cent were unsuccessful. For these he suggested that something more than pure oral teaching should be added.

Mr. Askew, of the Mary Hare Grammar School, pointed out that the born-deaf pupils entering his school at 13 + years were 2–3 years retarded in vocabulary. Prof. and Mrs. Ewing claim that with skilful home training from a very early age, deaf children of two had been trained to lip-read. But they have also admitted that all totally deaf children are not equally teachable.

My purpose was to plead for the experimental use of a systematic sign language, in which every sign should be the equivalent of a spoken word, and that suitable parents or nurses should be trained to use the new signs, and to talk to the young deaf children, *in signs*, just as a hearing mother talks to her young hearing children in words. In this experiment *no effort should be required on either side*. At first the deaf child would understand nothing: then gradually the meaning of the various signs would begin to dawn on them.

Mr. Greenaway had made the interesting suggestion that parents or nurses using the new sign language should speak as they signed. In this way the deaf children would get to realize that the mouth-gestures of speech and the pantomimic hand-gestures of the new sign language *meant* the same things. It seems not unlikely that at the age of four, totally deaf children might acquire a vocabulary of as many signs as a hearing child of equal intelligence would know words. A born deaf child of four with a vocabulary approaching 2,000 'words' would obviously be immensely more teachable than even the best of the pure oral successes. It is also obvious that signs which are completely visible should be much easier for the deaf child to imitate than spoken words are to the hearing child; for the method of manufacture of speech-sounds is largely a secret process.

I have made no 'recommendations'—I plead for the carrying out of an experiment which seems to offer valuable knowledge and material help to the young born deaf. I plead in good company, for when Lady Paget and I met Dr. Helen Keller in Cape Town last year, she was greatly interested in the new signs, and, after copying some of them for herself, she gave me this message: "Let the experiment be tried".

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In vitro Cultures of a Fern Callus

In recent years, several reports of the successful growth in sterile culture of callus tissues derived from various pteridophytes have appeared[1]. A callus culture possessing several unusual morphological, cytological and metabolic features has been obtained from gametophytes of *Pteridium aquilinum* (L.) Kuhn, var. *latiusculum* (Desv.) Underw.[2], which had been growing in sterile culture on an agar medium containing Knudson's solution of inorganic salts[3], Berthelot's trace element solution[4], 2 per cent glucose and 0·5 gm./l. yeast extract (autoclaved) at Harvard University, United States. Soon after these gametophyte cultures were brought to Manchester, England (in September 1950), a callus-like growth was observed in one of the tubes. When subcultured on to the same medium, with Knop's inorganic salt solution[4] substituted for Knudson's, the abnormal tissue continued to grow in a disorganized manner. It has now been through sixteen passages, each of four to six weeks duration, and in each passage there has been a six- to ten-fold increase in the size of the inoculum.

The cultures are deep green in colour and form coherent but friable masses. They are predominantly filamentous, with numerous branched filaments radiating from centres of growth. Continued divisions in various planes result in the formation of regions of highly vacuolated, large-celled parenchymatous tissue in some of the older parts of the cultures. Whitish or pale-green outgrowths project from the surfaces of many of the cultures. These are compact tissues composed of small, deeply staining parenchyma cells. Meristematic growth in the outgrowths is confined to certain localized superficial regions behind which is often a core of elongated cells. Some of these cells may be further differentiated as short scalariform or reticulate tracheids. A variety of treatments has as yet failed to promote further regenerative growth of these bud-like structures.

During the first two passages prothallial regeneration occurred on five occasions, but has not occurred since, either spontaneously or following experimental treatment. The strain of gametophytes from which the callus arose was haploid[5], $n = 52$. When first examined in the fourth passage, cells of the callus had approximately 100 chromosomes; but on subsequent examination of material in the twelfth and fourteenth passages chromosome numbers were found to vary irregularly between 150 and 200. The callus is now irregularly aneuploid.

Nutritional requirements of the callus are very simple. Slow but continued growth is possible on an agar medium containing inorganic salts only. Rapid growth occurs when inocula are totally submerged in a liquid medium containing only inorganic salts and 3 per cent glucose.

A detailed account of these cultures will be published elsewhere.

Our thanks are due to the late Mr. A. Swaffer and to Dr. C. M. Wilson and Mr. C. Partenan for assistance with the cytological studies.

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[1] Morel, G., *C.R. Acad. Sci., Paris*, **230**, 2318 (1950). Morel, G., and Wetmore, R. H., *Amer. J. Bot.*, **38**, 141 (1951). Wetmore, R. H., and Morel, G., *C.R. Acad. Sci., Paris*, **233**, 323, 430 (1951).
[2] Tryon, jun., R. M., *Rhodora*, **43**, 1, 37 (1941).
[3] Knudson, L., *Bot. Gaz.*, **79** 345 (1925).
[4] Gautheret, R.-J., "Manuel technique de culture des tissues végétaux" (Masson et Cie., Paris, 1942).
[5] Manton, I., "Problems of Cytology and Evolution in the Pteridophyta" (Cambridge University Press, 1950).

A Difference in *in vitro* Pancreatic Digestion between Animal and Plant Protein Feeds

MELNICK *et al.*[1] and Evans[2] found that the rate of enzymatic liberation of amino-acids from soybean proteins preheated at different temperatures provides an explanation for their different growth-promoting properties for the growing chick. We have used this principle to investigate the differences between the biological value of various types of protein feeding-stuffs for animals. In the course of this work we observed a property in which plant and animal proteins differ: pancreatic digests of plant protein feeds, but not of animal protein feeds, yielded considerable precipitates on addition of trichloracetic acid.

The experiments were carried out with feeding-stuffs defatted with ether and dried at room temperature. 6-gm. samples of each feed were placed in 250-ml. Erlenmeyer flasks, 300 mgm. of 'Pancreatin' (Byla, Paris), 150 ml. of phosphate buffer (pH = 8·2; Sørensen) and a few drops of toluene were added. The flasks and contents were incubated at 37–38° C. for 48 hr. with frequent shaking. In one set of experiments the non-digested materials were filtered, washed several times with phosphate buffer (pH = 8·2) and the nitrogen content of the precipitates was determined by Kjeldahl digestion. In a second set the whole digests (together with the substrates) were acidified with hydrochloric acid (methyl red) and 25 ml. of 5 per cent trichloracetic acid added. The precipitates were filtered and washed with hot water containing 0·5 per cent trichloracetic acid.

The precipitates obtained by addition of trichloracetic acid to plant protein digests contained much larger amounts of nitrogen than the non-digested residues by themselves, amounting to 20–25 per cent of the nitrogen contained in the original feeding-stuff. In the case of the pancreatic digests of animal-protein feeds, addition of trichloracetic acid did not cause precipitation of any additional quantity of nitrogen.

Feed	Total N-content of the fat-free feed (per cent)	Insoluble N after 48 hr. digestion with 'Pancreatin'	Insoluble and precipitated N after addition of CCl_3COOH to pancreatic digests
		In per cent of the N-content of the fat-free feed	
1. Fish meal (Norwegian)	11·6	40·1	40·1
2. Meat-meal (Argentinian)	11·4	25·0	25·3
3. Soy bean oil meal	7·7	10·3	30·0
4. Sesame oil meal	7·9	16·6	42·5

It may be noted that in similar digestion experiments carried out with pepsin (pH 1·5), no additional nitrogen was precipitated by trichloracetic acid, either in digests of plant proteins or in those of animal proteins.

Experiments to elucidate the chemical nature of these soluble nitrogen compounds precipitated by trichloracetic acid are under way.

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[1] Melnick, D., Oser, B. L., and Weiss, S., *Science*, **103**, 327 (1946).
[2] Evans, R. I., *Arch. Biochem.*, **11**, 15 (1946).

Production of Gliotoxin in Unsterilized Soil

IT has long been recognized that microbial antagonisms exist in the soil, and the possibility that this might be due to production of antibiotics has been suggested although never actually proved.

It has been shown that soil can be used as a medium for growth of many micro-organisms and also for antibiotic production, but in general sterilizing and supplementing with organic matter have been found to be necessary. Grossbard[1] has demonstrated the production of an antibiotic in autoclaved and also in partially sterilized soil, and Hessayon[2] has shown that activity can be produced in sterile unsupplemented soil. Gregory, Allen, Riker and Peterson[3,4], moreover, have demonstrated activity in unsterile soil which was, however, supplemented with highly nutrient organic matter. In these cases it was assumed, but not conclusively demonstrated, that the antibiotic formed in the soil was identical with that produced by the fungus in synthetic media.

The results presented here show the production of gliotoxin by *Trichoderma viride* in Wareham Heath soil, a highly acid podsol, in which all the microflora was present.

Unsterile soil was supplemented with dried clover, inoculated with a spore suspension of a gliotoxin-producing strain of *T. viride* and incubated at 25° C. for four days. The soil was extracted with ether and the extract used to demonstrate and identify the antibiotic.

Identification was demonstrated by a bio-assay based on paper chromatography. Chromatograms were run on the soil extracts, and solutions of pure gliotoxin on filter paper strips, and these were placed on agar seeded with *B. subtilis* as the test organism. After incubation of plates the distance moved by the active substance was demonstrated by the position of a clear zone of inhibition and the R_F values were calculated. The amount of gliotoxin present could be estimated roughly from the size of the inhibition zone.

	R_F values
Pure gliotoxin	0·60
Inoculated soil + 5 per cent clover	0·59
Inoculated soil + 2 per cent clover	0·59

Activity was produced only in inoculated unsterile soil to which dried clover had been added, and as

the R_F values of these extracts and pure gliotoxin were very similar, it was assumed that the activity was due to production of gliotoxin by the fungus. It was estimated, very approximately, that 0·6 μgm. of gliotoxin/gm. of soil was produced when 5 per cent dried clover was added. Activity was produced in soil to which only 1 per cent dried clover had been added.

A neutral garden loam was treated in the same way and inoculated with *T. viride*; but activity could only be demonstrated in soil which had been acidified. It has been shown by Jefferys[6] that inactivation of gliotoxin is more rapid in garden soil than in Wareham soil, and he related this to difference in *p*H, as gliotoxin is more stable at lower *p*H values.

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[1] Grossbard, E., *J. Gen. Microbiol.*, **6**, 295 (1952).
[2] Hessayon, D. G., *Nature*, **168**, 998 (1951).
[3] Gregory, K. F., Allen, O. N., Riker, A. J., and Peterson, W. H., *Bact. Proc. Soc. Amer. Bact., Chicago, Ill.*, 18 (1951).
[4] Gregory, K. F., Allen, O. N., Riker, A. J., and Peterson, W. H., *Amer. J. Bot.*, **39**, 405 (1952).
[5] Jefferys, E. G., *J. Gen. Microbiol.* (in the press).

Relationship of the Blood Sub-Groups A_1, A_2 and A_1B, A_2B to Hæmagglutinins Present in the Seeds of *Dolichos biflorus*

To identify the blood sub-groups of A and AB, an anti-A_1 serum is used. This is prepared by completely absorbing a human anti-A serum with A_2 cells[1]. The absorbed serum agglutinates A_1 and A_1B cells, but not A_2 or A_2B cells. A-specific hæmagglutinins have been demonstrated in saline extracts of the seeds of *Dolichos biflorus* by Bird[2], and it has been suggested[3] that because extracts of *Dolichos biflorus* seemed predominantly A_1-specific, they may be used to differentiate the sub-groups A_1 and A_2, A_1B and A_2B. The seed extracts have the advantage of being cheaper and more easy to prepare than human sera.

Two hundred samples of A and seventy-five of AB cells were therefore tested both with a human anti-A_1 serum and a saline extract of *Dolichos biflorus* seeds. All the samples were of Indians of no definite ethnological status and were obtained from the local blood-donor centre; 2 per cent suspensions of washed cells in isotonic saline were used. All the samples were less than 24 hr. old. The seeds used were those of *Dolichos biflorus*—Belgaum 1–1–8. They were extracted with isotonic saline by the simple method used by Boyd and Reguera[4] for small quantities of seeds. To differentiate A_1 from A_2 the seed extract was titrated against all the A samples. There was a clear-cut differentiation of the sub-groups of A, A_1 cells being agglutinated in titres ranging from 8,192 to 32,768; and A_2 cells in titres ranging from 4 to 16. In the case of AB cells, no titration was required as the undiluted extract agglutinates A_1B cells strongly and almost immediately, while it agglutinates A_2B cells weakly after about 15 min.

There was complete correspondence between the results obtained with the seed extract and those obtained with the absorbed human serum. There was no sample of A or AB which could not definitely be assigned to its proper sub-group; that is, there was no evidence of the occurrence of any 'A intermediates'. For routine work, a 1 in 64 dilution of the fresh extract in isotonic saline could be conveniently used to differentiate A_1 from A_2. This dilution can also be used to distinguish A_1B from A_2B, because A_1B cells are acted upon[3] up to a titre of 512.

Of the A samples, 177 (88·5 per cent) belonged to the sub-group A_1 and 23 (11·5 per cent) to A_2; while of the AB's, 60 (80 per cent) were A_1B and 15 (20 per cent) A_2B. As the numbers tested are small, and as the group examined was ethnologically indefinite, the anthropological aspect of these figures is not discussed.

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[1] Wiener, A. S., "Blood Groups and Transfusion" (Springfield, 1943).
[2] Bird, G. W. G., *Curr. Sci.*, **20**, 298 (1951).
[3] Bird, G. W. G., *Ind. J. Med. Res.*, **40**, 289 (1952).
[4] Boyd, W. C., and Reguera, R. M., *J. Immunol.*, **62**, 333 (1949).

Copepods New to British Waters

During a recent investigation on ascidicolous copepods, at least five species hitherto unrecorded from British waters have been found in Strangford Lough, Co. Down. All are members of the sub-order Notodelphyoida, and are listed below, together with their host ascidians.

Doroixys uncinata Kerschner: in *Polyclinum aurantium* Milne Edwards and *Sidnyum turbinatum* (Savigny).
Enterocola pterophora Chatton and Brément: in an unidentified didemnid.
Haplostomides scotti Chatton and Harant: in *Polyclinum aurantium*.
Haplostoma brevicauda (Canu): in *Polyclinum aurantium*, *Sidnyum turbinatum* and *S. elegans* (Giard).
Haplostoma banyulensis (Brément): in *Tridemnum tenerum* (Verrill).

Five other notodelphyoids so far known only from isolated localities around the British Isles and recorded, for the most part, many years ago, have also been discovered in Strangford Lough, and are given in the subjoined list.

Gunentophorus globularis Costa: in *Pyura squamulosa* (Alder) and *Polycarpa* sp.
Botryllophilus ruber Hesse: in *Botryllus schlosseri* (Pallas) and *Botrylloides leachi* (Savigny).
Enterocola fulgens P. J. van Beneden: in *Polyclinum aurantium*.
Haplostomides hibernicus (T. and A. Scott): in *Polyclinum aurantium*.
Mycophilus roseus Hesse: in *Botryllus schlosseri* and *Botrylloides leachi*.

I have hesitated for some time to assign specific identity to the *Mycophilus* collected, due to the presence of two forms in the lough. One of these is undoubtedly similar to that described by Chatton and Brément[1] as *Mycophilus curvatus*, while the other is apparently identical with *M. vararensis*, originally described by T. Scott[2] as *Enteropsis vararensis* but later annexed to the genus *Mycophilus* by Chatton and Brément. There seems to be little doubt that a third form described by Gray[3] as *M. rosovula* is synonymous with Scott's species. Lang[4], however, regards all members of this genus as referable to the single species *M. roseus*. My own work supports Lang's conclusion; it is hoped to discuss this question more fully in a separate paper.

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[1] Chatton and Brément, *Bull. Soc. Zool. France*, **34**, 234 (1909).
[2] Scott, T., Nineteenth Ann. Rep. Fish. Board Scotland, Pt. 3, 241 (1901).
[3] Gray, P., *J. Mar. Biol. Assoc.*, N.S., **2**, 18, 523 (1933).
[4] Lang, K., *Ark. f. Zool.*, **40A**, No. 14, 1 (1948).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 20

SOCIETY OF DAIRY TECHNOLOGY (in the North Hall, Victoria Halls, Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Dr. John Hammond, F.R.S.: "The Contributions of Artificial Insemination and Milk Recording to the Dairy Industry".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m. —Dr. Derek J. Price: "Chaucer's 'Equatorie of the Planetis' ".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Institution and Current Affairs" (to be opened by the President).

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. M. Barnes: "Crop Protection as a Health Hazard".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the INSTITUTE OF METAL FINISHING, at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Mr. R. M. Angles, Mr. S. C. Britton and Mr. D. G. Michael: "Tin-Nickel Alloy Coatings".

Tuesday, October 21

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Indian Culture, Past and Present".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Margaret Pyke and Mr. H. A. Davidson: "Family Planning—the Past and the Future".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Dr. L. Hartshorn: Chairman's Address.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. P. S. Williams: "The Flow of Concentrated Suspensions (related to Chemical Engineering Problems)".

TEXTILE INSTITUTE, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. F. Courtnay Harwood: "Modern Detergency".

Wednesday, October 22

ASLIB (at Friends House, Euston Road, London, N.W.1), at 5.30 p.m. —Mr. J. E. L. Farradane: "Psychology of Classification".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 8.30 p.m.—Dr. N. Tinbergen: "Some Recent Work on Instinct".

Thursday, October 23

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.— Dr. J. W. T. Walsh: Chairman's Address.

Friday, October 24

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, St. Thomas's Hospital Medical School, London, S.E.1), at 2 p.m.— Scientific Papers.

CHEMICAL SOCIETY, GLASGOW SECTION (joint meeting with the ALCHEMIST'S CLUB and the ANDERSONIAN CHEMICAL SOCIETY, at the Royal Technical College, Glasgow), at 3.30 p.m.—Prof. D. H. Hey: "Substitution at an Aromatic Carbon Atom".

CHEMICAL SOCIETY, BIRMINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. V. C. Barry: "Studies in the Chemotherapy of Tuberculosis".

BRITISH GLACIOLOGICAL SOCIETY (in the Department of Geography, Downing Place, Cambridge), at 8.15 p.m.—Prof. R. Finsterwalder: "Glacial Recession in the Eastern Alps since 1850, with special reference to Recent Times". (Members of the University are invited.)

Friday, October 24—Saturday, October 25

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1).—Autumn Conference.

Saturday, October 25

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the SCOTT POLAR RESEARCH INSTITUTE, at the Institute, Cambridge), at 8.30 p.m. —Dr. G. de Q. Robin: "The Norwegian–British–Swedish Antarctic Expedition, 1949–1952". (Members of the University are invited.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT BACTERIOLOGIST (science graduate, non-medical)—The Secretary and Administrative Medical Officer, Northern Regional Hospital Board, Raigmore, Inverness (October 25).

ENGINEERS (with good research experience) at the new Research Establishment at Isleworth, Middx, to undertake research work on underground mining problems—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/540 (October 25).

LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT of the Municipal Technical College—The Chief Education Officer, Guildhall, Kingston-upon-Hull (October 25).

SENIOR EXPERIMENTAL OFFICER at the Aeronautical Research Laboratory, Fishermen's Bend, Victoria, Australia, to be responsible under a P.S.O. (instrumentation) for the design, development, and manufacture of special instrumentation required for laboratories—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting No. 268 (October 25).

SENIOR SCIENTIFIC OFFICERS: (Position No. 3) to be responsible under direction of a P.S.O. for supervising a chemical section for research and investigations related to materials for rocket motors and rocket propellants; (Position No. 14) to be responsible under direction of a P.S.O. for supervising internal ballistics research in the field of rocket propulsion, including determination of ballistic properties of propellants and design of charges for rocket motors; PRINCIPAL SCIENTIFIC OFFICERS: (Position No. 24) to be responsible for initiation of research on the theoretical aspects of rocket propulsion and to supervise mathematical, thermodynamic and heat transfer studies in this field; (Position No. 34) to be responsible for the organization and direction of a propulsion engineering group, to initiate and supervise research and development on the engineering aspects of rocket motor design and exercise general supervision over an experimental workshop, drawing office and static firing emplacements; at the Propulsion Research Laboratory, Salisbury, Australia—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting the appropriate Ref. No. (October 25).

RESEARCH ASSISTANTS (2, with a first- or second-class honours degree, preferably in chemistry or biochemistry) in a newly formed Unit of Insect Biochemistry, to undertake research upon the biochemistry of locust blood—The Registrar, The University, Leeds 2 (October 27).

SENIOR PHYSICIST IN THE DEPARTMENT OF MEDICAL PHYSICS—The Secretary to the Board, United Bristol Hospitals, Royal Infirmary Branch, Marlborough Street, Bristol 2 (October 27).

MUSEUM ASSISTANTS in the Science Museum and the British Museum—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 143/229/52 (October 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF AGRICULTURE (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (October 31).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF MINING —The Registrar, University College, Cathays Park, Cardiff (October 31).

DEMONSTRATOR (honours graduate with previous experience of demonstrating to B.Sc. standard) IN THE PHYSICS DEPARTMENT—The Registrar, King's College, Strand, London, W.C.2 (October 31).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 31).

JUNIOR LECTURER IN ANATOMY—The Registrar, King's College, Strand, London, W.C.2 (October 31).

LECTURER (Grade II) or an ASSISTANT LECTURER (Grade III) in THE DEPARTMENT OF PHYSICS—The Secretary, The University, Birmingham 3 (October 31).

LECTURER IN PALÆONTOLOGY AND STRATIGRAPHY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (October 31).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY—The Registrar, University College of Wales, Aberystwyth (October 31).

LECTURER IN METALLURGY—The Registrar, King's College, Newcastle-upon-Tyne (October 31).

SCHOLARSHIP FOR TRAINING IN INDUSTRIAL RESEARCH—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (October 31).

HEAD OF THE DEPARTMENT OF BIOCHEMISTRY—The House Governor, Children's Hospital, Ladywood Road, Birmingham 16 (November 1).

TECHNICAL OFFICER, Grade II (with a good general training in chemistry, preferably up to degree standard; experience in fuel technology and fuel analysis would be an advantage) at the Coal Survey Laboratory in Scotland—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/539 (November 1).

SENIOR PRINCIPAL SCIENTIFIC OFFICER and PRINCIPAL SCIENTIFIC OFFICERS at the Army Operational Research Group, West Byfleet, Surrey, and a PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER at the Ordnance Survey Office, Chessington, Surrey—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4165/52 (November 6).

ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ANATOMY —The Registrar, University College, Cathays Park, Cardiff (November 8).

RESEARCH STUDENTSHIP IN THE DEPARTMENT OF BIOCHEMISTRY— The Secretary, Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1 (November 8).

SENIOR RESEARCH OFFICER (chemist or chemical engineer) at the Wool Textile Research Laboratory, Geelong, Victoria, Australia, to establish a section for research into certain processes of the textile industry, particularly felting and scouring—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3880 (November 8).

BROTHERTON LECTURER IN CHEMICAL ENGINEERING—The Registrar, The University, Leeds 2 (November 10).

ROSE SIDGWICK MEMORIAL FELLOWSHIP for a year's postgraduate study in the U.S.A., and the AURELIA HENRY REINHARDT INTERNATIONAL FELLOWSHIP for a year's research in some country other than the holder's own—Research Applications, British Federation of University Women, Ltd., 17a King's Road, London, S.W.3 (November 15).

DIRECTOR OF RESEARCH AT THE AUSTRALIAN LEATHER RESEARCH ASSOCIATION at Lane Cove, near Sydney, New South Wales—The Australian Leather Research Association, c/o the Chief Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (November 22).

LECTURER IN PHILOSOPHY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Melbourne, December 1).

POSTDOCTORATE FELLOWSHIPS for research in pure chemistry and physics, tenable in the National Research Council's laboratories at Ottawa, and POSTDOCTORATE FELLOWSHIPS in the biological sciences, tenable in the Prairie Regional Laboratory of the National Research Council at the University of Saskatchewan and in the Laboratories at Ottawa—The Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada; or the Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2 (February 15).

ASSISTANT (Grade A) IN BIOLOGY (qualified to take botany and/or zoology to Intermediate Degree standard), and an ASSISTANT (Grade A) IN PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT TECHNICAL SECRETARY (with a degree in metallurgy; some industrial experience essential, and a knowledge of sheet metal products an advantage) by the METALLURGY (GENERAL) DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Technical Secretary'.

BACTERIOLOGIST to undertake research work on the classification and identification of rumen bacteria by serological methods—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

CHAIR OF MATHEMATICS—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

CHEMIST (with good honours degree and Ph.D., or equivalent research experience) for work involving isolation and purification of new antibiotics and other substances of biological interest—The Director, Antibiotics Research Station (Medical Research Council), 4 Elton Road, Clevedon, Somerset.

CIVIL ENGINEER IN THE HYDROLOGICAL SURVEY DEPARTMENT, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.64/9/01.

DEMONSTRATOR IN AGRICULTURAL ZOOLOGY in the Department of Agricultural Sciences, School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

DEMONSTRATOR IN CHEMISTRY AND BIOLOGY—The Registrar, Technical College, Sunderland.

ENTOMOLOGIST IN THE DEPARTMENT OF AGRICULTURE, Trinidad, for investigation of plant damage by insects and other animals and formulation and application of control measures; also plant quarantine work—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.C.63/38/01.

GEOLOGIST (with honours degree in geology) for service in the Antarctic with the Falkland Islands Dependencies Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.33272.E.

GRADUATE CHEMIST for investigations of cleaning and lubrication in metal working processes (location, Sheffield)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Lubrication'.

HUGH WOOD MEMORIAL FELLOWSHIP IN MINING—The Registrar, The University, Leeds 2.

INDUSTRIAL CHEMIST at Harwell, to assist in problems associated with treatment of radioactive material, water supplies, and general chemical service—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.646/52A.

LECTURER IN BIOLOGY in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton, Staffs.

LECTURER IN MECHANICAL ENGINEERING, including heat engines and hydraulics—The Principal, Faraday House College, Southampton Row, London, W.C.1.

LECTURER IN ORGANIC CHEMISTRY, to teach organic chemistry to the standard of the Special Degree in Chemistry of London University, and the A.R.I.C.—The Registrar, Municipal College, Portsmouth.

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING—The Secretary and Registrar, The University, Southampton.

MYCOLOGIST (with an honours degree in botany, with experience of research in mycology and economic botany) IN THE FOREST DEPARTMENT, KENYA, to study pathology in forests and plantations and the fungal diseases of timber—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.61/7/01.

PROFESSOR OF MECHANICAL ENGINEERING and a PROFESSOR OF ELECTRICAL ENGINEERING at the University of Roorkee, U.P., Northern India, to teach and organize their departments on modern lines with up-to-date undergraduate and postgraduate courses and research—The Ministry of Labour and National Service, Technical and Scientific Register (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/I.65,66E/52.

RESEARCH ASSISTANT (with a good honours degree in physics, mathematics or chemical engineering, and some research experience) IN THE DEPARTMENT OF MINING AND FUELS—The Registrar, The University, Nottingham.

RESEARCH ASSISTANT (with a good degree in zoology and, preferably, a special interest in physiology and histology)—The Professor of Zoology, The University, Glasgow, W.2.

RESEARCH DEMONSTRATOR (honours graduate in botany) IN THE DEPARTMENT OF BIOLOGY—The Registrar, University College, Singleton Park, Swansea.

RESEARCH MANAGER at Sellafield, Cumberland, to take charge of Laboratories engaged on metallurgical development of radioactive materials and welding processes for atomic energy—The Ministry of Supply, Civision of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 376.

RESEARCH PHYSICIST (with at least a second-class honours degree in physics) for work in the field of SOLID STATE PHYSICS—The Professor of Physics, The University, Reading.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER for an investigation on the soundness of iron castings—The British Cast Iron Research Association, Alvechurch, Birmingham.

SENIOR ENGINEER, WATER SUPPLY AND IRRIGATION DEPARTMENT, Cyprus—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.64/17/01.

SENIOR PHYSICIST (with experience in medical physics) for RADIOTHERAPY SERVICE of the Southampton area—The Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton.

SURVEYORS IN UGANDA, to carry out and supervise cadastral and topographical surveys—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.72/9/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1864 : 1952, Milk Piping and Milk Pipe Fittings. Pp. 34. (London: British Standards Institution, 1952.) 5*s*. net. [306

Eighty-eighth Annual Report on Alkali &c. Works. By the Chief Inspectors. Proceedings during the Year 1951. Pp. 64. (London: H.M. Stationery Office, 1952.) 2*s*. net. [17

British Empire Cancer Campaign. Twenty-ninth Annual Report, covering the Year 1951. Edited by Sir Heneage Ogilvie. Pp. xxix+358. (London: British Empire Cancer Campaign, 1952.) [17

Colonial Office. Fishery Publications, Vol. 1, No. 2: Report on the Tilapia and other Fish and Fisheries of Lake Nyasa, 1945–47. By Rosemary H. Lowe. Pp. x+126+7 plates. (London: H.M. Stationery Office, 1952.) 40*s*. net. [27

Bulletin of the British Museum (Natural History). Zoology, Vol. 1, No. 7: The Cestodes of Seals from the Antarctic. By Stanislaw Markowski. Pp. 123–150+plates 10–21. (London: British Museum (Natural History), 1952.) 12*s*. 6*d*. [27

Flora of Tropical East Africa. Editors: Dr. W. B. Turrill and E. Milne-Redhead. Part 2: Oleaceæ. Pp. 31. (London: Crown Agents for the Colonies, 1952.) 2*s*. 9*d*. [27

Other Countries

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Carnegie Institution of Washington Year Book No. 50, for the Year 1950–1951.) Pp. 34+4 plates. (Washington, D.C.: Carnegie Institution, 1951.) [236

Western Australia. Report of the Government Chemical Laboratories for the Year 1949. Pp. 40. (Perth: Government Printer, 1951.) [236

Transactions of the Conference on Morale and the Prevention and Control of Panic, held under the joint auspices of the New York Academy of Medicine and the Josiah Macy Jr. Foundation, Feb. 2, 1951. Pp. ii+75. (New York: New York Academy of Medicine, 1952.) [246

Fieldiana. Anthropology, Vol. 37, No. 2: Bibliography of African Anthropology, 1937–1949. Supplement to Source Book of African Anthropology, 1937. By Wilfrid D. Hambly. Pp. 153–292. (Chicago: Chicago Natural History Museum, 1952.) 1.50 dollars. [246

Discussion on Radiation Microbiology and Biochemistry, given at Research Conference for Biology and Medicine of the Atomic Energy Commission, sponsored by the Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 11–12, 1949. Pp. 128. (Oak Ridge, Tenn.: Oak Ridge National Laboratory, 1952.) [246

Queensland Institute of Medical Research. Sixth Annual Report, Year ended 30th June 1951. Pp. 18. (Brisbane: Queensland Institute of Medical Research, 1952.) [256

Ontario Research Foundation. Annual Report, 1951. Pp. 26. (Toronto: Ontario Research Foundation, 1952.) [306

Scientific Papers of the College of General Education, University of Tokyo. Vol. 1, No. 1, October 1951. Pp. ii+102. (Tokyo: University of Tokyo, 1951.) [306

Ministry of Public Works, Egypt: Nile Control Department. Paper No. 1: Probability in the Hydrology of the Nile. By Naguib Boulos. Pp. vii+67. (Cairo: Government Press, 1951.) P.T. 50; 10*s*. [306

Proceedings of the American Academy of Arts and Sciences. Vol. 80, Part 1: Contributions to the Analysis and Synthesis of Knowledge. (Published in co-operation with the Institute for the Unity of Science.) Pp. 112. (Boston, Mass.: American Academy of Arts and Sciences, 1951.) 2 dollars. [306

Annotated List of Animals and Plants of Mie Prefecture, Japan. Pp. vii+352. (Tsu: Committee of the Biological Survey of Mie Prefecture, University of Mie, 1951.) [27

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes rendus de recherches, No. 7: Travaux de la Section de Pathologie du Fonds de la Recherche sur la Pomme de Terre. Pp. 118. 135 francs. Rapport Annuel, 1951. Pp. 196. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1952.) [37

Catalogues

Vitreosil Hydrogen Discharge Lamps. (Ref. No. LL/14/5/52.) Pp. 4. (Wallsend: The Thermal Syndicate, Ltd., 1952.)

Mullard Ultrasonic Soldering Equipment. Pp. 8. (London: Mullard, Ltd., 1952.)

Astronomy, Mathematics, Physics. (Catalogue 19.) Pp. 64. (London: E. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1952.)

Manual Polarographs. Pp. 4. (Worsley, Lancs.: Electrochemical Laboratories, 1952.)